BY ORDER OF THE
SECRETARY OF THE AIR FORCE

AIR FORCE MANUAL 48-125

4 OCTOBER 2011
Incorporating Change IC-2,
22 FEBRUARY 2016

Aerospace Medicine

PERSONNEL IONIZING RADIATION DOSIMETRY

COMPLIANCE WITH THIS PUBLICATION IS MANDATORY

ACCESSIBILITY: Publications and forms are available on the e-Publishing website at **www.e-Publishing.af.mil** for downloading or ordering.

RELEASABILITY: There are no releasability restrictions on this publication.

OPR: AFMSA/SG3PB

Certified by: USAF/SG3
(Col Collier)

Supersedes: AFMAN48-125, 7 August 2006

Pages: 109

This manual implements Air Force Policy Directive (AFPD) 48-1, *Aerospace Medicine Program*, and interfaces with Air Force Instruction (AFI) 40-201, *Managing Radioactive Materials in the USAF*, and AFI 48-148, *Ionizing Radiation Protection*. It establishes and describes the Air Force (AF) Personnel Ionizing Radiation Dosimetry Program. It explains the purpose and gives instructions for operating an Occupational Radiation Dosimetry Program at the base level, to include monitoring in non-routine and contingency operations. This AFMAN ensure that all records created as a result of processes prescribed in this publication are maintained IAW with AFMAN 33-363, Management of Records, and disposed of in accordance with the Air Force Records Disposition Schedule (RDS) located at **https://www.my.af.mil/gcss-af61a/afrims/afrima**/. This publication requires the collection and or maintenance of information protected by the Privacy Act (PA) of 1974. The authority to collect and or maintain the records prescribed in this publication is DODI 6055.08 "Occupational Ionizing Radiation Protection Program." The use of the name or mark of any specific manufacturer, commercial product, commodity, or service in this publication does not imply endorsement by the Air Force. Refer recommended changes and questions about this publication to the Office of Primary Responsibility (OPR) using the AF Form 847, *Recommendation for Change of Publication;* route AF Form 847s from the field through the appropriate chain of command.

SUMMARY OF CHANGES

The manual implements updated requirements and procedures for organizations using the USAF Personnel Ionizing Radiation Dosimetry Program. Major changes include required monitoring for certain radiation workers based on job description based on their potential for and for anyone who is likely to exceed an external dose of 100 mrem or 2% of the annual limits of intake (ALI). This manual requires all pregnant radiation workers to be monitored throughout their gestation period. It clarifies the bodily placement of specific types of dosimeters and addresses procedures for the assignment of administrative doses. The manual also clarifies the management of electronic personnel dosimeters in regards to use and calibration oversight. Dosimetry program checklists, references and definitions have been updated.

Chapter 1

INTRODUCTION

1.1. Objective. This manual describes procedures essential for successful operation of the USAF Personnel Ionizing Radiation Dosimetry Program (hereafter referred to as the Dosimetry Program), particularly at base level. It documents the implementation of external and internal radiation monitoring policies established in Title 10, Code of Federal Regulations, Part 20 (10 CFR 20) and AFI 48-148, *Ionizing Radiation Protection*. In addition, this manual provides information to assist the Installation Radiation Safety Officer (IRSO) and Thermoluminescent Dosimetry (TLD) Program Monitor in managing their dosimetry program.

1.2. Purpose. This manual establishes the requirements and procedures for organizations using the Dosimetry Program to monitor personnel occupational exposures to ionizing radiation. This manual also establishes the basic procedures for personnel who have occupational exposures to radiation. Examples of occupational exposures include exposures that occur during the operation of x-ray equipment or during response to a radiological or nuclear accident or incident. Occupational exposures do not include exposures resulting from naturally occurring background radiation (whether cosmic or terrestrial sources) or exposures received as a patient undergoing medical diagnosis or treatment. The Dosimetry Program is designed to monitor, when necessary, occupational radiation exposures. All Dosimetry Program monitoring results are maintained permanently in the USAF Master Radiation Exposure Registry (MRER), which is maintained by the USAF School of Aerospace Medicine, Analytical Services Division (USAFSAM/OEA).

1.3. Program Eligibility. Personnel eligible to participate in this program include:

1.3.1. Military and civilian Air Force, Air Force Reserves and Air National Guard occupational radiation workers who require personnel radiation dosimetry monitoring as identified by the IRSO. Air Force dosimetry services may be provided to contractor personnel if the contract states these and other occupational medicine services will be provided.

1.3.2. Military and civilian occupational radiation workers of other Department of Defense (DOD) agencies. Under terms of agreements between USAFSAM/OEA and the Radiation Dosimetry Centers of DOD sister services or agencies, all personnel monitoring results for individuals in this category will be stored in the USAF MRER and may be reported to the responsible Service or Agency dosimetry center.

1.3.3. Occupational radiation workers employed by federal, state, or local government agencies outside DOD. These individuals may receive personnel monitoring from USAFSAM/OEA on a fee-for-services basis under terms of agreements between USAFSAM/OEA and their agency radiation safety office.

1.4. Overview of Routine Operations.

1.4.1. General. The Dosimetry Program is operated at the base level by the IRSO (usually a Bioenvironmental Engineer (BE), a Senior BE Noncommissioned Officer, or a qualified civilian employee) and a designated TLD Program Monitor, usually a BE Technician, (Air Force Specialty Code [AFSC] 4BOX1) or qualified civilian employee. The IRSO identifies personnel to be monitored, determines how many administrative areas are needed to cover

the entire base, assigns a letter or number to designate those areas, determines the monitoring frequency (monthly, quarterly, or semi-annually), and provides this information to USAFSAM/OEA. Each installation is assigned a unique base code that is used to identify the base in all Dosimetry Program records. USAFSAM/OEA registers individuals into the program according to their base code. USAFSAM/OEA separates each base dosimeter issue into the designated monitoring areas and issues TLDs and extremity dosimeters for either a monthly, quarterly, or semi-annual monitoring period as specified by the IRSO. At the end of the monitoring period, the TLD Monitor retrieves issued dosimeters and issues a new set of dosimeters to the monitored individuals. The TLDs are removed from the whole body, collar, and neutron hangers and are placed into the shipping tray (if one was supplied). The TLDs and extremity dosimeters are packaged and returned to USAFSAM/OEA for processing. Dose equivalent reports are forwarded to the IRSO for review, to confirm that the values reported are appropriate for the individual and the monitoring period and for use in managing the installation-level radiation safety program. This cycle is repeated until the IRSO removes the individuals from the program, cancels monitoring for that area, or the individual leaves the work area through a permanent change of station, separation, or retirement.

1.4.2. Who is Monitored. Detailed guidance for individuals requiring monitoring is contained in AFI 48-148. In general, monitoring is required for certain radiation workers based on job description and their potential for and for anyone who is likely to exceed an external dose of 100 mrem or 2% of the annual limits of intake (ALI). Individuals who work with unsealed radioactive sources and are at risk of obtaining an internal exposure greater than 2% of the ALI will be also included in a bioassay program (see paragraph 4.7). Pregnant radiation workers are to be monitored throughout their gestation period. It is important to remember that the decision to enroll individuals in the monitoring program is made by the IRSO.

1.4.3. Area Control Dosimeters. USAFSAM/OEA provides area control dosimeters for each radiation exposure area and dosimeter type worn in that area. Area control dosimeters are used to measure background radiation accumulated during transit or storage of dosimeters and are handled in the same manner as the dosimeters issued to individuals. To provide an accurate measurement of an individual's occupational dose, the dose assessed using a five-year average daily background of control dosimeters is subtracted from the dose recorded on the issued dosimeter. Use of a five-year average daily background ensures accurate background subtraction for late returned badges. An area control dosimeter shall never be used for monitoring an individual. The area control dosimeter is always maintained in the TLD storage rack or designated TLD storage area used for issued dosimeters when they are not being worn. Area control dosimeters must be returned to USAFSAM/OEA at the end of the monitoring period along with the dosimeters issued during the monitoring period. Each area must have a control dosimeter for each dosimeter type (e.g., one whole body dosimeter, one neutron dosimeter, one extremity dosimeter).

1.4.4. Storage of TLDs. Any dosimeter, when not being worn, must be stored with its associated control dosimeter on a dosimeter storage rack or in a storage area designated by the IRSO. The storage area must be as free from radiation sources as possible and away from excessive heat or moisture. Dosimeters are to be used only in the designated work area. They are **not** to be stored in/on an individual's desk or placed onto the dashboard of a

vehicle. Proper control and storage of dosimeters is important to ensure the dosimeters are not tampered with, can be returned for processing, and can provide a dose representative of the working environment. Improper storage adversely affects the accuracy of dose assessment and may result in a need for an exposure investigation by the IRSO.

1.4.5. Extra (Spare) Dosimeters. USAFSAM/OEA provides extra (spare) dosimeters with each routine shipment. When a new person is identified as requiring monitoring, the individual needs to be added to the Dosimetry Program. Instead of waiting for a TLD or extremity dosimeter to be issued from USAFSAM/OEA, extra dosimeters can be used to allow the individual to immediately start working. When using extra dosimeters, the Dosimetry Assignment Data Form (RDL Listing 1523) must be properly annotated to provide all necessary information for USAFSAM/OEA to register the individual in the Dosimetry Program. **All extra dosimeters, whether issued or not, are to be returned to USAFSAM/OEA at the end of the monitoring period.** There is no preprinted wear location on RDL Listing 1523 for extra dosimeters. The wear location must be designated when the dosimeter is issued. Customers may request an increase in their quarterly issue to maintain enough extra TLDs for emergency response operations. TLDs that are requested for this purpose must be handled in a manner consistent with all personnel TLDs. Should the spare TLD be issued to personnel for emergency response, that information should be annotated on the RDL Listing 1523.

1.4.6. Returning Dosimeters for Processing

1.4.6.1. Routine dosimeter shipments shall be postmarked for shipment by the 10th calendar day following the end of the monitoring period. (T-2) All shipments shall be accompanied by the "Returning Dosimeters Checklist", **Attachment 4**. (T-2)

1.4.6.2. Exchange dosimeters from previous monitoring period for dosimeters from the current monitoring period to include Area Control, Personnel, and Spare TLDs. Check all dosimeters to be shipped against the current version of the Radiation Dosimetry Laboratory Electronic (RDL) Listing 1523 and ensure that all "Not Returned" dosimeters are indicated on the RDL Listing 1523 by typing NR, TDY, or Lost, in the Comment Field. Dosimeters used in Special Surveys must be designated as such on the RDL Listing 1523 and the physical location identified in the Comment Field. (T-2) The RDL Listing 1523 must be reviewed by IRSO or Alternate IRSO and all changes to the RDL Listing 1523 must be submitted and reviewed by the RDL prior to shipping the dosimeters. (T-2) Discard all labels in a manner designed to ensure that privacy act information is handled properly**.** ***Exception: Late Return dosimeters should be accompanied with the original dosimeter labels supplied by the RDL to facilitate tracking upon receipt.***

1.4.6.3. Dosimeters must be screened with radiation monitoring instrumentation (capable of alpha and beta measurements) to ensure no exterior contamination is present before shipping. (T-2) Please refer to the "Addendum to the Bioenvironmental Engineer's Guide to Ionizing Radiation: Appendix F Installation-Level Internal Dosimetry Program".

1.4.6.4. Dosimeters must be separated by monitoring periods and clearly identified. (T-2) Dosimeters designated for Special Surveys may be returned with the routine shipment; however, they must be placed in separate sealable plastic bags, e.g. Ziploc®, and clearly identified. (T-2)

1.4.6.5. Place all extremity dosimeters in sealable plastic bags. (T-2)

1.4.6.6. If a Panasonic TL dosimeter tray is provided by the RDL, the dosimeters must be placed into shipping tray appropriately: upright, secured with rubber bands, and placed in plastic sleeves (if provided by the RDL) and returned. (T-2) If a Panasonic TL dosimeter tray is ***NOT*** provided by the RDL: all dosimeters must be separated by monitoring periods, placed into sealable plastic bags, and the monitor period clearly identified on the bag. (T-2)

1.4.6.7. If the dosimeters were received in a single, double or triple tray type box, the original shipping box (single, double, or triple) must be used to return the dosimeters. (T-2) If the RDL ***DID NOT*** ship your TLDs in a single, double, or triple tray type box, an appropriate shipping container must be used to ensure they are protected and returned in an orderly manner. (T-2) ***Note: Letter style (paper) envelopes are NOT acceptable.*** The contents of the package must be secured by adding bubble wrap (as required) and the shipping container properly sealed. (T-2) ***Note: Bubble wrap is the only approved packing material.*** A "CAUTION" label provided by the RDL should be attached to the shipping container next to the address label ***and*** on the reverse side of the container. ***Note: The RDL will provide additional "Caution" labels at the request of the customer.*** (T-2)

1.4.6.8. The package must be shipped by the most expeditious and traceable means, e.g., FedEx, Certified Mail, UPS, or DHL and addressed to: (see **Figure 1.1**) (T-2)

Figure 1.1. Address.

USAF Radiation Dosimetry Laboratory 2510 Fifth St, Area B Building 0840 Room W 329 Wright-Patterson AFB, OH 45433-7913
Note: Dosimeters should not be shipped on Friday nor should they be marked for Saturday or other after-duty hours delivery.

1.4.7. Returning Electronic Personal Dosimeters (EPDs) for Calibration

1.4.7.1. Remove all batteries from the EPDs prior to packaging and dispose of them properly in accordance with your installations established protocols. (T-2)

1.4.7.2. All EPD shipments shall be packaged to ensure that the devices are not damaged during transportation. (T-2) The contents of the package must be secured by adding bubble wrap (as required) and the shipping container properly sealed. (T-2)

1.4.7.3. A memorandum for record must be included with each shipment providing, as a minimum, the following information: (T-2)

1.4.7.3.1. Total number of EPDs within the package.

1.4.7.3.2. Serial Number of each EPD contained within the package.

1.4.7.3.3. The Installation/Unit having ownership of the EPDs.

1.4.7.3.4. How each EPD is used by the Installation/Unit (e.g., Readiness, NDI, etc.).

1.4.7.3.5. The physical mailing address for the return of the EPDs post-calibration. **Note: The RDL uses FedEx for return shipments whenever possible. FedEx cannot ship to an APO, please contact the RDL for more information."**

1.4.7.4. Packages sent to USAFSAM/OEA should be shipped by the most expeditious and traceable means to the address listed in section **1.4.6.8**.

1.5. Additional Guidance.

1.5.1. Investigation Action Levels (IALs). To ensure doses are maintained As Low As Reasonably Achievable (ALARA), IALs defined by the IRSO should not be lower than the analytical system's lower limit of detection (LLD). USAFSAM/OEA has determined the appropriate LLD for dosimeters issued to field operations to be 0.1 mSv [10 millirem (mrem)]. External radiation doses less than the LLD are assigned as zero in the MRER. The IAL, or the dose equivalent value or radionuclide intake activity, should be set by the IRSO. These levels require further investigation when exceeded. IALs are normally tailored to each using section's historical dosimetry data in order to promptly identify and correct adverse trends.

1.5.2. Special Studies. Installations often use TLDs to conduct area surveys and for other special studies not directly measuring the radiation dose to uniquely identified individuals (see paragraphs 7.4 and 7.5). USAFSAM/OEA will supply appropriate dosimeters and associated controls as required to support special studies. **Note: Issued whole body dosimeters are not to be used for this purpose.**

1.5.3. Dosimetry for Visitors. Visitors entering high radiation areas [0.1 rem (1 mSv) in 1 hour at 30 cm from the radiation source or at 30 cm from any surface that the radiation penetrates] and very high radiation areas [500 rads (5 Gy) in 1 hour at 1 m from a radiation source or at 1 m from any surface that the radiation penetrates] are required to be monitored. Visitors who may receive a dose exceeding 10% of public dose limits should be afforded monitoring (see paragraph 7.3). This can be accomplished by issuing TLDs or Electronic Personnel Dosimeters (EPDs). The extra TLDs, provided with each TLD shipment may be issued for monitoring visitors entering radiation areas. All TLDs issued for this purpose should be annotated on the RDL Listing 1523 to include the required personnel information. Visitors who are issued TLDs or have a non-zero dose measured on a self-reading dosimeter must be registered in the Dosimetry Program for the monitoring period in which the visit occurred. If a visitor's dose is measured with a self-reading dosimeter, the local IRSO is to be notified and any non-zero dose results must be forwarded to USAFSAM/OEA in writing by the IRSO for inclusion in the MRER. Only self-reading dosimeters having a current calibration in accordance with Precision Measurement Equipment Laboratory (PMEL) requirements may be used for this purpose.

1.6. Non-routine Operations (Emergency, Contingency & Weapons of Mass Destruction [WMD] Response Actions).

1.6.1. In general, the processes and procedures in this manual will be used for all radiation related deployments or emergencies.

1.6.2. Electronic Personnel Dosimeters (EPD) are incorporated in installation response plans and use of these devices is outlined in paragraph 3.3.

Chapter 2

RESPONSIBILITIES

2.1. Deputy Secretary of the Air Force (Environment, Safety and Occupational Health (SAF/IEE)) Provides oversight for all Air Force policy related to environment, safety, and occupational health.

2.2. The Surgeon General (HQ USAF/SG). Provides guidance for operating the Dosimetry Program and ensures the program complies with federal rules and regulations, DOD and Air Force policy, emergency response requirements, military deployment requirements and accepted scientific practice.

2.3. Commander, Air Force Materiel Command (HQ AFMC/CC), through Command Surgeon Air Force Materiel Command (HQ AFMC/SG). Implements the Dosimetry Program. USAFSAM/OEA provides operational control.

2.4. Commander, 711th Human Performance Wing (711th HPW/CC). Provides and maintains the facilities and personnel to conduct external dosimetry, bioassay analyses, and internal dose calculations. (T-1)

2.5. Commander, US Air Force School of Aerospace Medicine (USAFSAM/CC), through USAFSAM/OEA.

2.5.1. Establishes and maintains accreditation for the Dosimetry Program through the National Voluntary Laboratory Accreditation Program (NVLAP) administered by the National Institute of Standards and Technology (NIST) in the following categories at a minimum:

2.5.1.1. Whole body dosimeters. Low and high-energy photons (protection and accident ranges), beta particles, neutrons, and mixtures (ANSI/HPS N13.11-2009 performance test categories I-V, inclusive).

2.5.1.2. Extremity dosimeters. Low and high-energy photons, beta particles (ANSI/HPS N13.32-2008 performance test categories I-C, II-A, III, and IV-A).

2.5.1.3. Neutron dosimeters. High-energy photons and neutrons (ANSI/HPS N13.11-2009 performance test categories II and V).

2.5.2. Provides, processes and analyzes NVLAP accredited TLDs for external monitoring of personnel identified by the IRSO meeting the criteria in Chapter 1, paragraph 1.3 and AFI 48-148.

2.5.3. Prepares and provides reports, listings or other documentation as may be necessary to ensure IRSO has information necessary to effectively administer the installation-level program.

2.5.4. Provides 24 hour per day on-call technical assistance to the IRSO, or other individuals as may be appropriate, on external radiation dosimetry and program operations.

2.5.5. Ensures all internal and external dosimetry results are incorporated into the MRER.

2.5.6. Briefs the USAF Radioisotope Committee quarterly on program status and statistical trends for the previous quarter.

2.5.7. Provides a written annual summary report and briefing to the USAF Radioisotope Committee at the 2nd quarter meeting which details program status and statistical trends for the previous calendar year.

2.5.8. Establishes and maintains a dosimetry record system to conform to the record keeping requirements of Title 10, Code of Federal Regulations, Part 20, Section 2106 (10 CFR 20.2106).

2.5.9. Ensures recording of non-occupational radiation doses delineates these records from occupational radiation doses via database codes and/or fields.

2.5.10. Refers radon issues and inquiries to the appropriate OPR as outlined in AFI 48-148, Ionizing Radiation Protection, and paragraph 5.3.

2.5.11. Establishes and operates the deployable Air Force Radiation Assessment Team (AFRAT) which provides an external ionizing radiation dosimetry capability to support normal and contingency operation ionizing radiation monitoring requirements.

2.6. Commander, USAFSAM/CC, through the Analytical Services Division (USAFSAM/OEA).

2.6.1. Establishes and maintains comprehensive radioanalytical capability necessary to assess potential internal deposition of radioactive material for Air Force personnel.

2.6.2. Processes and analyzes bioassay samples in accordance with scientifically established and approved analytical procedures.

2.6.3. Ensures bioassay analysis and dose assessment, RSO approval, and entry of dose of record into MRER.(T-1)

2.6.4. Maintains internal dosimetry records in accordance with the record keeping requirements of 10 CFR 20.2106.

2.6.5. Provides on-call technical support to the IRSO or other field activities, as may be appropriate, on internal bioassay requirements and methods.

2.6.6. Provides notice to base bioenvironmental engineer/IRSO whenever changes to procedures, algorithms, or analytical methods may result in change to baseline results or impact data quality.

2.6.7. Ensures results are entered into the appropriate Occupational Health Management Information System (OH-MIS), when available.

2.7. Installation Commander through the IRSO. Ensures occupational radiation exposure received by installation personnel is kept below all applicable standards and ALARA and, when monitoring is provided or required, is properly assessed and documented.

2.8. Medical Treatment Facility (MTF) Commander (or equivalent).

2.8.1. Recommends to the installation commander when personnel need to be relieved from duties that could involve further radiation exposure. This will occur when the MTF commander determines the individuals have been, or are likely to be, exposed to ionizing radiation in excess of limits specified in 10 CFR 20 and AFI 48-148. The guidance in AFI 48-148 will be used for major nuclear accidents, terrorist attacks, and combat operations.

2.8.2. Accomplishes tests, as may be necessary, to medically evaluate an individual's exposure to radiation in the event of a potential overexposure.

2.8.3. If the IRSO is assigned from the BE office, the Medical Group Commander will make the IRSO available to support the installation program and ensures the IRSO is properly qualified and trained to perform radiation safety duties.

2.8.4. Ensures declared-pregnant individuals working in potential occupational radiation exposure environments are referred to the IRSO for enrollment in the Dosimetry Program on a monthly monitoring frequency. **Note: Declared pregnant individuals referred to the IRSO will be placed on a monthly badge exchange frequency (see paragraph 6).**

2.9. BE/ IRSO.

2.9.1. Conducts the Dosimetry Program at base level per AFI 48-148 and this manual. **Note: In some cases program management may be assigned to other offices and individuals depending on the organizational structure and the availability of suitable radiation expertise.**

2.9.2. Determines that individuals and work areas meet one or more of the monitoring conditions specified in paragraph 1.3.

2.9.3. Determines the type of external monitoring required (i.e., body, head, extremity, beta/gamma/neutron), the length of the monitoring period, and the type and scope of any bioassay procedures (e.g., urine sampling, fecal sampling, etc).

2.9.4. Requests records of an individual's prior occupational radiation dose in accordance with (IAW) 10 CFR 20.2104, at the time an individual registers in the Dosimetry Program.

2.9.5. Upon referral from Public Health (PH):

2.9.5.1. Conducts workplace evaluation and exposure assessment for pregnant employees.

2.9.5.2. Notifies PH of the scope of the radiation hazard and any recommended duty restrictions.

2.9.5.3. Ensures that pregnant Air Force military radiation workers and declared pregnant civilian Air Force employees are enrolled into the Dosimetry Program and placed on a monthly monitoring schedule, as required (see paragraph 6).

2.9.5.4. Ensures that pregnant radiation workers already enrolled in the Dosimetry Program and meeting the above criteria are placed on a monthly badge exchange frequency.

2.9.5.5. Approves dosimeter storage locations.

2.9.6. Briefs personnel enrolling in the Dosimetry Program on the following:

2.9.6.1. Proper wear and storage of TLDs.

2.9.6.2. Procedures for collecting any required bioassay samples.

2.9.6.3. Hazards associated with ionizing radiation and methods to keep their exposure ALARA.

2.9.6.4. Additional briefing requirements for female radiation workers:

2.9.6.4.1. Hazards associated with exposure to ionizing radiation during pregnancy.

2.9.6.4.2. Their responsibility to report to PH as soon as possible following confirmation of pregnancy, and the need to be placed on a monthly dosimeter exchange frequency.

2.9.7. Ensures Air Force personnel being monitored by organizations other than USAFSAM/OEA or having bioassay samples analyzed by organizations other than USAFSAM/OEA are aware of the requirement to provide copies of any monitoring results to the IRSO. The IRSO will forward copies to USAFSAM/OEA. (T-3)

2.9.8. Establishes a program for monitoring visitors.

2.9.9. Reports and investigates abnormal and overexposures per this manual (see Chapters 9 and 10).

2.9.10. Requests priority processing from USAFSAM/OEA for dosimeters issued to pregnant workers or used in planned special exposures.

2.9.11. Maintains and reviews forms and listings received from USAFSAM/OEA to ensure accuracy and completeness and promptly notifies USAFSAM/OEA of any changes as may be appropriate.

2.9.12. Provides and reviews a copy of the *Cumulative Occupational Exposure History to Ionizing Radiation* (AF Form 1527-1) to each person monitored (for more detail see paragraph 4.6.5).

2.9.13. Serves as the OPR for all contingency EPDs on the installation. Will collect and ensure that all contingency EPDs are calibrated annually. The IRSO will maintain all EPD readers on the installation. Ensures at least one thermoluminescent dosimeter (in addition to the EPD) per individual in a co-located group of responders—either whole body or whole body and neutron depending on the type of radiation potentially present.

2.9.14. Ensures first responders are knowledgeable of dose guidance in AFI 48-148.

2.10. Public Health Office (PH). Assists preparation of a pregnancy profile based upon physician recommendations and BE/IRSO occupational and environmental health risk assessment (including radiation exposure).

2.11. Unit Commander with Individuals in the Dosimetry Program.

2.11.1. Ensures the unit implements all the requirements of this manual. Additional references may be found in Attachment 4.

2.11.2. Ensures all personnel exposures are always below established limits and are ALARA.

2.12. Supervisor of Individuals in the Dosimetry Program.

2.12.1. Ensures all personnel exposures are below established limits and are ALARA.

2.12.2. Ensures dosimeters are properly worn, handled and secured when worn or not in use per this AFM. This includes utilization of the control board and control badge.

2.12.3. Refers newly assigned personnel and visitors who will enter into an area requiring TLDs to the IRSO for entry into the Dosimetry Program prior to starting work involving occupational exposure to ionizing radiation.

2.12.4. Promptly refer pregnant military personnel and declared-pregnant civilian personnel to:

2.12.4.1. PH for establishment of a pregnancy profile and

2.12.4.2. IRSO for placement into the monthly monitoring program.

2.12.5. Reviews the Occupational Radiation Exposure Report (Current) (RDL Listing 1499) and associated IRSO comments and takes necessary action to address errors or possible adverse trends.

2.12.6. Maintains RDL Listing 1499 and provides dosimetry results to personnel upon request. Forms are maintained until the IRSO has distributed the AF Form 1527-1 or *Cumulative Occupational Exposure History to Ionizing Radiation* (AF Form 1527-2) to individuals covering the same monitoring period.

2.12.7. Cooperates in the assessment of assigned administrative doses due to loss, stolen, destroyed, or otherwise unaccountable personnel dosimeters.

2.13. Individual Participants in the Dosimetry Program.

2.13.1. Ensure personnel exposures are below established standards and are ALARA.

2.13.2. Provide the IRSO with all relevant personal dosimetry information. Such information includes, but is not limited to, listing current or prior history of occupational radiation exposure.

2.13.3. Review dosimetry results provided by USAFSAM/OEA via RDL Listing 1499, AF Form 1527-1 and (or) AF Form 1527-2 promptly upon receipt and reports any errors noted to the IRSO.

2.13.4. Comply with any requirements for bioassay sample collection.

2.13.5. Cooperate in the assessment of assigned administrative doses due to individual loss, stolen, destroyed, or otherwise unaccounted for personnel dosimeters.

2.13.6. Every female military member shall, on becoming aware that she is pregnant, notify her workplace supervisor or primary care manager.

2.13.7. Female non-military members should notify their workplace supervisor or primary care manager to ensure the safety of the fetus. **Note: It is important to remember that a civilian or non-military woman's decision to declare her pregnancy is entirely voluntary. It is the fundamental responsibility of the pregnant non-military worker to decide when and if she will formally declare her pregnancy via a signed letter. If not already enrolled in a monitoring program, the declared-pregnant non-military worker may request to be enrolled in the Dosimetry Program at her discretion. If monitoring is required, IAW AFI 48-148 monitoring will be provided as a normal course of employment and is not discretionary.**

2.13.8. Properly use issued dosimeters per instructions provided by the IRSO and in this manual. Disciplinary action may result for anyone who willfully engages in deliberate

exposure, destruction, contamination, falsification or tampering with dosimeters, bioassay samples, or records of dosimetry results.

Chapter 3

DESCRIPTION OF AIR FORCE DOSIMETERS

3.1. Air Force Whole Body and Collar Dosimeters. Please refer to Attachment 3 for additional technical and operational details. **All AF personnel must wear USAFSAM/OEA approved and calibrated dosimeters. Dosimeters other than the models listed in this AFMAN must be approved by USAFSAM.**

3.1.1. Panasonic UD-802 Whole Body Dosimeter and 820 Hanger Combination – "Smoke Holder" (General Purpose Dosimeter). This general-purpose dosimeter is used to measure radiation exposures to the whole body. The dosimeter is sensitive to beta, gamma, x-ray, and neutron radiation. It must be worn by all personnel enrolled in the Dosimetry Program regardless of other type(s) of dosimeters worn. Exceptions to this wear policy exist, but need to be coordinated through USAFSAM/OEA. If specialty dosimeters such as the collar or extremity dosimeters are not worn, the whole body dosimeter will also be used to determine dose equivalents for the head, lens of the eye, and extremities. This dosimeter is clipped on outer clothing in the front part of the body below the neck and above the waist. **When worn with a collar dosimeter, the whole body dosimeter is always worn underneath any lead apron. When worn without a collar dosimeter and a lead apron is worn, the whole body dosimeter is worn on the individual's collar, outside any protective shielding. When a whole body dosimeter is not being worn, it is stored with the area control dosimeter.** RDL Listing 1523 designates this wear location as "BODY."

Figure 3.1. Typical UD-802 Whole Body Dosimeter in Smoke (Clear) Hanger.

3.1.2. Panasonic UD-802 Collar Dosimeter. A collar dosimeter is the primary device used to evaluate exposures to the head and lens of the eye and, when applicable, to facilitate calculating the effective dose equivalent under the special monitoring circumstances described in Chapter 4. Consideration for wearing this dosimeter should be given to individuals engaged in fluoroscopic examinations, in the operation of portable medical x-ray equipment, in performing cardiac catheterizations, or who otherwise may wear protective lead aprons and for whom the whole body dosimeter may not provide an accurate assessment of dose to the head, neck, or lens of the eye. **The collar dosimeter is always worn outside any shielded protective covering.** The collar dosimeter may be placed in a red hanger to facilitate verification of proper placement while worn in conjunction with a whole body dosimeter; however, if the collar dosimeter is the *only* dosimeter used then it shall be placed in the standard smoke hanger. A collar dosimeter should be worn as near to the thyroid as possible to determine the unshielded exposure to the head and lens of the eye. When a collar dosimeter is not being worn, it is stored with the area control dosimeters. RDL Listing 1523

designates this wear location as "COLL." The IRSO should contact USAFSAM/OEA for guidance in other circumstances such as a desire to provide collar dosimetry service.

3.1.3. Panasonic UD-802 Whole Body Dosimeter/811 Hanger Combination - "Amber Hanger" (Neutron Dosimeter). This dosimeter/hanger configuration is a specialized design that provides enhanced capability to measure doses due to exposure to neutrons. This is accomplished by the incorporation of a cadmium filter into the hanger. The cadmium filter improves the dosimeter's response to the wide range of neutron energies that may be operationally encountered. A neutron dosimeter is the primary device for determining the neutron dose equivalents to the whole body. **The neutron dosimeter is never worn without a whole body badge.** Since the neutron dosimeter is an albedo device (i.e., it uses the scattered neutrons from the user's body to determine the dose equivalent), it must be worn flat against the body, at the midsection of the individual, with the back of the dosimeter next to the body. **Note: The back of the dosimeter is clearly indicated by the presence of a pre-printed identification label.** When a neutron dosimeter is not being worn, it is stored with the area control dosimeters. RDL Listing 1523 designates this wear location as "NBOD."

Figure 3.2. Typical UD-802 Dosimeter in Amber Hanger.

3.2. Air Force Extremity Dosimeters. Please refer to Attachment 3 for additional technical and operational details. **All AF personnel must wear USAFSAM/OEA approved and calibrated dosimeters. Dosimeters other than the models listed in this AFMAN must be approved by USAFSAM.**

3.2.1. General Description. USAFSAM/OEA has characterized one extremity (ring) dosimetry system – the "EXT-RAD", developed by Thermo Electron Radiation Measurement and Protection. The EXT-RAD system is an active phosphor chipstrate assembled into sealed pouches and worn in band-aid style rings. The EXT-RAD dosimeter is able to be cold sterilized. It is bar-coded, has human-readable identity and is reusable. The extremity dosimeter is the primary device to evaluate exposures to the hand and forearm of an individual. **The extremity dosimeter is never worn without a whole body dosimeter.** The ring should be worn on the finger that will receive the highest dose of radiation from the source and must be oriented so that the circular indentation is facing the radiation source. If the extremity dosimeter is worn with leaded gloves, it is worn under the shielded gloves. When an extremity dosimeter is not being worn, it is stored with the area control dosimeters. RDL Listing 1523 designates this wear location as "RING".

3.2.2. Extremity Dosimeter Response at Nonstandard Beta Energies. The dose calculation algorithms for the single element extremity dosimeter (EXT-RAD) do not automatically compensate for exposures to beta radiation at energies other than those used to characterize

the dosimeter (i.e., 0.556 MeV $^{90}Sr/^{90}Y$ and 0.267 MeV ^{204}Tl). **Note: Because of this inherent limitation in dosimeter design, it is important that the customer advise USAFSAM/OEA of the type and energy of beta radiation for which the dosimeter is to be evaluated so that appropriate correction factors can be applied.**

Figure 3.3. EXT-RAD "band-aid" Chipstrate Extremity Dosimeter.

Figure 3.4. EXT-RAD Extremity Dosimeter in Use.

3.3. Air Force Electronic Personnel Dosimeters (EPDs). All AF personnel must wear USAFSAM/OEA approved and calibrated dosimeters. Dosimeters other than the models listed in this AFMAN must be approved by USAFSAM. The use of these dosimeters is reserved for special circumstances such as emergency response and selected Occupation Codes. Contact USAFSAM/OEA for further guidance *prior* to issue or use of this technology. **Note: Currently USAFSAM/OEA is recommending these units as supplemental dosimetry to be used in conjunction with the TLD system.**

3.3.1. When the Thermo Electron Mark 2 and N2 are used to assess dose to personnel those dose records must be provided to USAFSAM/OEA by the IRSO using the EPD Dose Processing Worksheet for inclusion in the MRER. (T-2) USAFSAM/OEA can issue EPDs to individual personnel on a case-by-case basis, please contact them for guidance/more information.

3.3.2. USAFSAM/OEA will conduct all calibrations of Thermo Electron Mark 2 and N2 EPD technology in use within the AF.

3.3.2.1. EPDs used for First Responder Teams or other emergency responders as outlined in AFI 10-2501, Air Force Emergency Management (EM) Plans and Programs, require calibration on an annual basis

3.3.2.2. EPDs used for personnel monitoring on a regular basis will require a six-month calibration cycle.

3.3.3. Thermo Electron's Electronic Personal Dosimeter – Mk2. The EPD Mk2 is an electronic dosimeter that detects, measures, and records beta and gamma radiation. The EPD Mk2 detects radiation and processes it to give an indication of deep dose, shallow dose, and the dose rate. This information is displayed to the user via an LCD display on the top of the EPD. The EPD also has various dose and dose-rate alarms that can be set to alert the wearer of a potential radiological hazard. Mk2 EPDs are preset by USAFSAM/OEA and should not be adjusted by the end user. If custom alarm set-points are required, please contact USAFSAM/OEA to create a profile for your installation.

3.3.4. Thermo Electron's Electronic Personnel Dosimeter – EPD N2. The EPD N2 works in the same way as the EPD Mk2, except it detects neutron and photon radiation instead of beta and photon radiation.

3.3.4.1. N2 EPDs are currently used for WMD First Responders exclusively. These EPDs are preset by USAFSAM/OEA and should not be adjusted by the end user.

3.4. EPD Support for Contingency Operations.

3.4.1. Definitions

3.4.1.1. Installation Radiological Response Operation – Any incident or accident that poses a radiological threat to military personnel, ranging from exposure to depleted uranium (DU) munitions, to the hazards posed by a potential terrorist use of improvised nuclear devices (INDs), radiological dispersion devices (RDDs), or an accident or incident in the nuclear stockpile. Additionally, historical commercial nuclear power plant incidents indicate that accidents and/or malevolent use of radioactive material from civilian sources is possible and may have direct impact on AF installations.

3.4.1.2. Contingency EPDs – A stockpile of EPDs maintained by the AF Personnel Ionizing Radiation Dosimetry Program that can potentially be assigned and shipped to AF installations requiring surge support during a Radiological Response Operation.

3.4.2. Procedure

3.4.2.1. The IRSO will determine the number of personnel that must be monitored utilizing EPDs during the Radiological Response Operation, as defined in 3.4.1.1 above,

3.4.2.2. The IRSO must make a determination that personnel monitoring cannot be accomplished with the EPD inventory currently available on the installation.

3.4.2.3. The IRSO will determine the minimum number of EPDs required to augment the available inventory based on the number of personnel to be monitored, the monitoring period/frequency, and currently available EPD inventory.

3.4.2.4. The IRSO will submit, with a courtesy copy to their respective MAJCOM BE, a written request to the ESOH Service Center including the analysis as described in **3.4.2.1** – **3.4.2.3** above.

3.4.2.5. The ESOH Service Center will relay the request to the AF Radiation Dosimetry Program Director (RDPD) or the Dosimetry Laboratory Technical Director (DLTD).

3.4.2.6. The RDPD and DLTD will process the request IAW established Operating Instructions.

3.4.2.7. The AF Personnel Ionizing Radiation Dosimetry Program will make every effort to process all requests within 24 hours of notification.

3.4.2.8. The AF Personnel Ionizing Radiation Dosimetry Program will, when available, provide a means for the return shipment of the devices once the operation is complete.

3.5. EPD Use for Dose of Record.

3.5.1. General. EPDs read for dose at the installation level may be included within the USAF Master Radiation Exposure Registry (MRER) and be covered by the USAF National Voluntary Laboratory Accreditation Program (NVLAP) Ionizing Radiation Dosimetry Program.

3.5.2. Procedure. In order for the EPD dose to be included within the MRER and covered by the USAF Radiation Dosimetry Program's NVLAP Accreditation the following criteria ***must*** be met

3.5.2.1. The EPD ***must*** have a valid calibration conducted by the USAF Radiation Dosimetry Laboratory.

3.5.2.2. The EPD ***must*** be "read" and "zeroed" prior to being issued to another individual.

3.5.2.3. The installation radiation safety officer or designee must complete and sign the Electronic Personal Dosimeter Dose Processing Worksheet (EPDDPW) and submit same to the AF Personnel Ionizing Radiation Dosimetry Program. Please note: This form is not meant to replace the procedure established for Assigned Doses. If an Installation RSO wishes to assign a dose to monitored personnel utilizing dose information from an EPD those may still be submitted through the radiation Dosimetry Web Application.

3.5.2.4. The EPDDPW is an interactive Adobe Acrobat form that allows the RSO or designee to complete and digitally sign the document from any AF NIRPNET terminal. The customer will click on each field and provide the required information. All fields outlined in red are mandatory. An RSO signature is required on each form. Failure to provide signed forms to the USAF Dosimetry Laboratory will prevent/delay processing of the doses into the MRER. The EPDDPW can be found in **Attachment 6**.

Chapter 4

CONDUCTING AN INSTALLATION-LEVEL DOSIMETRY PROGRAM

4.1. General. Detailed guidance on managing installation-level Dosimetry Programs is contained in this chapter.

4.2. Monitoring Criteria. Eligible persons (see paragraph 1.3) shall be entered into the Dosimetry Program based on the requirements of AFI 48-148.

4.2.1. Personnel monitoring may be provided to individuals not meeting any of the above criteria if the IRSO determines that any of the following applies:

4.2.1.1. The type of radiation to which the individual could be exposed is detectable by personnel monitoring equipment.

4.2.1.2. Provision of monitoring services would be helpful in demonstrating compliance with ALARA.

4.2.1.3. Monitoring is desirable to evaluate potential exposure conditions to allay concern.

4.3. Monitoring Period.

4.3.1. General. Most personnel enrolled in the Dosimetry Program have TLDs that are exchanged quarterly. Factors necessitating more frequent exchange, i.e., monthly exchange, might include prior exposure history of the unit for individuals performing similar duties, prior exposure history of the individual beginning work as an occupational radiation worker, the potential for accumulating radiation doses at a high or irregular rate, training of individuals, etc. The appropriate exchange frequency for personnel dosimeters is determined by the IRSO.

4.3.2. Normal Exchange Frequency.

4.3.2.1. Most occupational radiation exposure circumstances encountered within the USAF can be adequately monitored by using dosimeters exchanged on a quarterly (i.e., 3 months) basis. Using quarterly monitoring periods generally provides optimum accuracy for low dose rate environments.

4.3.2.2. Monitoring at shorter frequencies (e.g., monthly) may be appropriate under special circumstances, as detailed below:

4.3.2.2.1. Occupational radiation workers who are pregnant (civilian workers must declare their pregnancy) will be monitored monthly (see Chapter 6).

4.3.2.2.2. Certain operations having an exceptionally high radiation exposure potential (e.g., greater than 1.25 rem per quarter) may necessitate a monthly exchange frequency.

4.4. Determining Prior Occupational Dose.

4.4.1. In accordance with AFI 48-148 and 10 CFR 20.2104, individuals enrolled in personnel monitoring programs should provide information regarding their current and past history of occupational radiation exposure at the time of enrollment.

4.4.2. For each individual who is likely to receive, in a year, an occupational dose requiring monitoring, the IRSO shall:

4.4.2.1. Request the records of the occupational internal and external radiation dose that the individual received during the current year.

4.4.2.2. Attempt to obtain the records of cumulative occupational radiation dose.

4.4.3. It is ultimately the individual's responsibility to provide records of prior non-AF occupational dose to the IRSO.

4.4.4. In complying with the requirements of this paragraph, the IRSO may:

4.4.4.1. Accept, as a record of the occupational dose that the individual received during the current year, a written signed statement from the individual, or from the individual's most recent employer for work involving radiation exposure, that discloses the nature and amount of any occupational dose the individual may have received during the current year *or*

4.4.4.2. Accept, as a record of the cumulative radiation dose, an up-to-date AF Form 1527-2 obtained from USAFSAM/OEA if the individual certifies by signature that the AF Form 1527-2 contains records of his or her complete radiation exposure history *or*

4.4.4.3. Accept, as a record of the cumulative radiation dose, an up-to-date Nuclear Regulatory Commission (NRC) Form 4, Cumulative Occupational Exposure History, or equivalent, signed by the individual and countersigned by an appropriate official (along with office/title of responsibility: IRSO, supervisor, contract monitor, etc.) of the most recent employer for work involving radiation exposure, or the individual's current employer; and

4.4.4.4. Obtain reports of the individual's dose equivalents from the most recent former employer for work involving radiation exposure or the individual's current employer by telephone, telegram, electronic media or letter. Written verification of dose data will be requested if the authenticity of the transmitted report cannot be established.

4.4.5. The IRSO, as required by this chapter, shall take into account an individual's prior exposure history and ensure any additional occupational radiation exposure received as a result of USAF or concurrent moonlighting operations does not exceed allowable occupational exposure limits as specified in 10 CFR 20 and AFI 48-148. Individuals, whose prior exposure history exceeds allowable occupational exposure limits for the current calendar year either as a result of AF or concurrent moonlighting activities, will be immediately removed from all duties involving occupational radiation exposure and will not be monitored by the Dosimetry Program.

4.4.6. If the IRSO is unable to obtain a complete record of an individual's current and previously accumulated occupational dose, the IRSO shall assume:

4.4.6.1. In establishing administrative controls for the calendar current year, that the allowable dose limit for the individual is reduced by 12.5 mSv (1.25 rem) for each quarter records were unavailable and the individual was engaged in activities that could have resulted in occupational radiation exposure; and

4.4.6.2. That the individual is not available for planned special exposures.

4.5. Exposures Incurred during Secondary ("Moonlighting") Employment. USAF occupationally exposed individuals, monitored under the Dosimetry Program, are prohibited from exceeding the dose limits specified in 10 CFR 20 and AFI 48-148, regardless of the source of exposure. Because of this, it is necessary to consider the radiation exposure an individual may receive from employment outside the USAF. **Note: AF occupational radiation workers may not wear their AF-issued TLDs while moonlighting.**

4.5.1. NRC Form 4, Occupational Radiation Exposure History. Upon initial entry or re-entry in the Dosimetry Program, radiation workers are required to provide radiation exposure histories [NRC Form 4 or as stated in 10 CFR 20.2104, (c)] from previous employers prior to beginning work. This includes, but is not limited to, individuals who may have studied at civilian or military institutions for advanced degrees. The NRC Form 4 or its equivalent is used to record radiation exposures from previous employers outside of the USAF. This request is normally initiated by the IRSO with the individual signing a statement allowing the release of Privacy Act information. **IAW AFI 48-148 all dose equivalent histories of previous employment outside the USAF must be forwarded to USAFSAM/OEA for inclusion in the MRER.**

4.5.2. NRC Form 5, Current Occupational Radiation Exposure. All Air Force employees involved in off duty employment and registered in the Dosimetry Program are required to provide current radiation exposure summaries. The NRC Form 5, or its equivalent, is used to record radiation exposures to USAF personnel who have off duty employment involving radiation exposures, and are provided dosimeters by an institution other than the USAF. **IAW AFI 48-148, the individual must furnish dose equivalent information from off duty employment at least quarterly to the local IRSO. The IRSO must forward this information to USAFSAM/OEA for entry into the MRER.**

4.6. Personnel Monitoring for Exposure to Radiation from an External Agency.

4.6.1. All persons monitored by the USAF through USAFSAM/OEA, or working for the USAF but monitored by another agency, must be registered in the Dosimetry Program.

4.6.2. USAFSAM/OEA sends dosimeters to the IRSO or medical organization conducting the Dosimetry Program. Electronic RDL Listing 1523 containing information on all registered individuals will be automatically generated and available via the Radiation Dosimetry Web secure website. (see 4.10.1)

4.6.3. At the end of each monitoring period, the IRSO exchanges the dosimeters and ships the old dosimeters to USAFSAM/OEA as described in section 1.4.6. (T-2)

4.6.4. USAFSAM/OEA processes all dosimeters and the IRSO, using the Radiation Dosimetry Web secure website, retrieves a RDL Listing 1499 with the individual exposures for the monitoring period. For more information on the Radiation Dosimetry Web, please contact USAFSAM/OEA.

4.6.4.1. The IRSO reviews the RDL Listing 1499 and distributes a copy to the supervisor of the monitored individuals.

4.6.4.2. The IRSO evaluates any administrative doses assigned by USAFSAM/OEA on the RDL Listing 1499 due to lost or damaged dosimeters, to determine the most likely dose received by the individual for the given monitoring period (see Chapter 5).

4.6.5. USAFSAM/OEA annually provides the IRSO, via the Radiation Dosimetry Web, with an AF Form 1527-1 for each individual entered in the Dosimetry Program for the previous calendar year. (For more information on the Radiation Dosimetry Web, please contact USAFSAM/OEA.) The IRSO provides these forms to each individual in the Dosimetry Program within 30 days of receipt. 10 CFR 19.13(c) states the IRSO will establish a system (e.g., logbook, copy of AF Form 1527-1 signed by the individual, etc.) to document receipt of this information by the individual.

4.7. Personnel Monitoring for Exposure to Radiation from Internally Deposited Radioactive Materials.

4.7.1. **Introduction.** Internal dosimetry is "…the science of assessing the amount and distribution of radionuclides in the body, and calculating resulting radiation doses to internal organs or tissues over specific time periods" (ANSI/HPS N13.39-2001). The intent of this section is to provide guidelines for achieving the minimum levels of acceptable performance in evaluating the internal radiation doses that may be received by radiation workers from intakes of radionuclides.

4.7.2. **Bioassay**

4.7.2.1. Monitoring is required for any individual who is likely to internalize through a completed exposure pathway (inhale or ingest, primarily), without regard to protective controls, more than 0.02 times the Annual Limit of Intake (ALI) in a calendar year. (T-1) BE and Biomedical Laboratory personnel will maintain radiobioassay sampling and internal dosimetry plans on file for units with the monitored individuals. (T-2) The conditions requiring bioassay, as well as the methods and maximum intervals discussed below, are designed to ensure that an annual intake exceeding this amount can be quantified.

4.7.2.2. For continuous operations involving unsealed radioactive material, and when individuals involved are likely to exceed 2% of the ALI as result of inhalation, ingestion, injection, or absorption of radioactive materials routine bioassay (sampling on a regular interval) should be performed to document exposure concomitant with intake of radioactive material and to confirm that exposure controls are functioning.

4.7.2.2.1. Baseline bioassays shall be collected upon beginning of employment or before beginning work with radioactive materials. (T-2) When submitting the sample to the laboratory, request analysis for the nuclide(s) to which the individual may be exposed.

4.7.2.2.2. Bioassay frequency, the maximum time that may elapse between periodic samples, is a critical component to ensuring detection of the intake. The bioassay frequency for a specific nuclide is determined by the desired level of detection, metabolic characteristics of the radioactive material, and the analytical method used. IRSOs and PRSOs implementing routine bioassay programs should contact USAFSAM/OE at 1-888-232-ESOH (3764), DSN 798-3764, or email **esoh.service.center@wpafb.af.mil**, to discuss frequency, sampling strategy, and possible termination of sampling.

4.7.2.3. Special bioassay should be used to quantify radionuclide intakes when individuals involved in a planned project are likely to exceed 2% of the ALI as result of

inhalation, ingestion, injection, or absorption of radioactive materials. Special bioassay monitoring consists of pre-event and post-event samples:

4.7.2.3.1. Pre-event assay: An assay sample should be conducted as close as possible to the start date of the event that has the potential to result in an intake. When submitting the sample to the laboratory, request analysis for the nuclide(s) to which the individual may be exposed during the event. (T-2)

4.7.2.3.2. Post-event assay: To determine the exposure associated with the project, collect another bioassay sample during the project (process details and laboratory detection limits influence adequate sampling strategy) and/or after work is completed. (T-2) Consultation with USAFSAM/OE prior to the project can be key to the success of the risk assessment. Monitored personnel, in conjunction with the IRSOs and PRSOs, shall make every effort to ensure that sampling and submission occur within the appropriate interval. (T-2)

4.7.2.4. **Sampling & Submission for Analysis**

4.7.2.4.1. Sample Collection: It is recommended that the IRSO or PRSO (or designee) contact USAFSAM/OE Analytical Services Customer Service prior to collecting any bioassay samples, including those for baseline purposes. This will ensure that the IRSO is provided the necessary guidance resulting the most accurate analysis and results. When contacting Customer Service the following information will be needed, as a minimum:

4.7.2.4.1.1. What is the requirement for sampling?

4.7.2.4.1.2. What is the maximum exposure potential (isotope)?

4.7.2.4.1.3. When are the workers exposed and at what frequency?

4.7.2.4.2. Detailed instructions on bioassay sample collections are included within the USAF School of Aerospace Medicine Laboratory Sampling and Analysis Guide § 5.8. USAFSAM/OEA Customer Service can also provide guidance regarding sampling media, protocol, and supplies.

4.7.2.4.3. Submission of Samples to the Analytical Services Division: The Defense Occupational and Environmental Health Readiness System (DOEHRS) Sample Submission form (located at the ESOH Service Center website (**https://hpws.afrl.af.mil/dhp/OE/ESOHSC/**) is preferred acceptable documentation for the submission of bioassay samples to USAFSAM/OE for analysis. [Only if DOEHRS is unavailable one may use USAFSAM 2753 found at the ESOH Service Center website]. For sample submission questions, contact USAFSAM/OEA Customer Service. For general DOEHRS assistance, contact the DOEHRS Support Office at **USAFSAMDOEHRSSUPPORT@us.af.mil.**

4.7.2.4.4. Sample Analysis: All bioassay sample analysis conducted for the purposes of evaluating individual radiation exposure (radionuclide intake) shall be conducted in accordance with ANSI/HPS N13.30. (T-2)

4.7.2.4.5. Reporting: USAFSAM/OE will provide a written analysis report to the IRSO detailing the results of the laboratory analyses. In the event that the Installation RSO is not the Permit RSO, the report shall be forwarded to the Permit RSO.

4.7.2.4.6. Results Review (QA/QC): The RSO(s) shall review analytical results to verify bioassay analysis was conducted, and/or for values that indicate presence of radionuclides in the sample. (T-2) RSOs should contact the laboratory with any questions or if results appear aberrant.

4.7.3. **Internal Dose Assessment**

4.7.3.1. **Initiating Dose Calculations:** USAFSAM/OE will use non-baseline bioassay analysis results to perform a dose assessment calculation in accordance with ANSI/ HPS N13.39. (T-2)

4.7.3.2. **Reporting Dose Assessment:** Upon completion and verification of all calculations, USAFSAM/OE will provide to the IRSO a written summary of: information provided on the bioassay sample submission, calculated intake, percentage of the stochastic ALI, committed effective dose equivalent, and committed dose equivalent for the maximally exposed organ. (T-2)

4.7.3.3. **RSO Concurrence:** The USAFSAM/OE Internal Dose Assessment summary will contain a statement of concurrence for either the IRSO or PRSO to sign. (T-2)

4.7.3.3.1. If the Dose Assessment is tied to a permitted operation, the PRSO will indicate concurrence by signing/dating the Dose Assessment summary sheet (located at the ESOH Service Center website (**https://hpws.afrl.af.mil/dhp/OE/ESOHSC/**) and returning it to the IRSO to facilitate to USAFSAM/OE. If the dose is not from a permitted operation, the IRSO will indicate concurrence by signing/dating the summary and returning it to USAFSAM/OE. (T-2)

4.7.3.3.2. Failure of the RSO to complete **4.7.3.3.1** within 10 working days of receipt, or if the RSO does not concur with the reported dose, will result in USAFSAM/OE elevating the summary to the AF Radiation Safety Committee for resolution.

4.7.3.4. **Entry into the MRER:** Once the signed Internal Dose Assessment Summary is received, or upon resolution of non-concurrence, USAFSAM/OE will upload the results into the MRER. (T-1) These results will be reported on the AF Form 1527-1, *Annual Occupational Exposure History to Ionizing Radiation* or the Form 1527-2, *Cumulative Occupational Exposure History to Ionizing Radiation*.

4.8. Wearing and Handling of Dosimeters.

4.8.1. General.

4.8.1.1. Dosimeters are to be placed in the proper position on the body prior to entering a radiation area or handling radioactive materials. Dosimeters are to be removed upon leaving the radiation work place and stored in a location designated by the IRSO.

4.8.1.2. Each dosimeter hanger is uniquely identified with a label provided by USAFSAM/OEA. If it is necessary to make any changes to this label, the original print must remain legible to properly account for the card and dosimeter.

4.8.1.3. Dosimeters must not be inscribed with any type of name, number or other identifying information. To ensure accurate dose assessments, dosimeters must not be

covered with any foreign material such as duct tape, masking tape or labels not furnished by USAFSAM/OEA.

4.8.1.4. Each whole body dosimeter has a thin Mylar™ window designed to aid in evaluating exposures from low energy radiation. Dosimeters must be visually inspected before use to confirm this window is present and intact. Dosimeters with missing or damaged windows are not to be used and must be returned to the IRSO for exchange.

4.8.2. Whole Body Dosimeters. This type of dosimeter is designed to measure radiation exposure to the whole body (or major portion of the whole body) and is to be worn on the front of the body below the neck and above the waist on the outside of clothing. The front surface of the dosimeter faces away from the body. Normally, whole body exposures to beta, gamma and x-radiation are assessed by use of a single whole body dosimeter.

4.8.2.1. When a lead apron or similar protective garment is used, a separate collar dosimeter may be issued. If a separate collar dosimeter is issued, whole body dosimeters are worn on the outside of basic clothing but beneath the protective garment. When a separate collar dosimeter is not issued and a lead apron is worn, the whole body dosimeter is worn on the individual's collar outside of protective shielding.

4.8.2.2. In certain situations, multiple dosimeters may be issued. These are generally used to assess localized exposures and must never be worn in lieu of the whole body dosimeter.

4.8.3. Collar Dosimeters. These dosimeters are used to assess dose to the head, neck, and lens of the eye, and are used to supplement the whole body dosimeter that is worn beneath a protective lead apron. The collar dosimeter is always worn outside any shielded protective covering and as near the thyroid as is possible.

4.8.4. Neutron Dosimeters. Specialized dosimeters are issued to monitor occupational exposure to neutron radiation. Neutron and whole body dosimeters are always worn simultaneously, in the same approximate location and in the same manner as whole body dosimeters. Examples of circumstances where neutron dosimeters may be required include: individuals working around medical or industrial accelerators that operate at greater than 13 MeV, work with radioactive materials that emit neutrons (e.g., ^{238}Pu/Be sources, ^{252}Cf sources, or nuclear weapon systems), or work around operating nuclear reactors. The accuracy of neutron dosimetry is greatly enhanced when the energy spectrum of neutron radiation to which the individual is exposed is known. The IRSO should consult with USAFSAM for assistance in characterizing site-specific neutron energy spectra.

4.8.5. Extremity Dosimeters. Extremity dosimeters (most commonly finger rings) will be worn by persons determined by the IRSO as likely to exceed 2 percent of the applicable extremity dose limit in 10 CFR 20 and AFI 48-148. Dosimeters must be worn underneath any protective garments (e.g., surgical gloves and leaded gloves), on the dominant hand and with the circular indentation facing toward the radiation source. Extremity dosimeters are always worn simultaneously with whole body dosimeters.

4.9. Storing Dosimeters.

4.9.1. The IRSO designates dosimeter storage areas remote from ionizing radiation sources. The number and location of these storage areas is determined by the IRSO, as needed to support local programs.

4.9.2. Dosimeter storage areas must be free of oil, dust, or other contaminants.

4.9.3. Dosimeters must not be stored in areas of high temperature or moisture.

4.9.4. A designated control dosimeter must be placed in each dosimeter storage area for the entire monitoring period.

4.9.5. Dosimeters must not be stored in places not approved by the IRSO.

4.10. The Radiation Dosimetry Web Secure Website.

4.10.1. The Radiation Dosimetry Web (RDW) is a secure website that can be accessed by the IRSO, the TLD Monitor, and assigned Alternates. To obtain access each user must register their Common Access Card to the Human Performance Wing Support (HPWS) Gateway. Once registration is complete the user may request access to the Radiation Dosimetry Web from the main page of the HPWS Gateway. Once the request has been processed by USAFSAM/OEA the user should receive an E-mail informing them of the final disposition of their request.

4.10.2. The following six common dosimetry customer service tasks should be accomplished using this system:

4.10.2.1. Base Information Change Request—Used to change information about your base: mailing address or delivery address, new IRSO (or alternate where applicable), new TLD Monitor, new telephone or fax number, status of Dosimetry Program (active, inactive), etc.

4.10.2.2. Personnel Information Change Request—Used to add a person to the program, delete (deactivate) a person in the program, or request a change, e.g., new area, different dosimeters.

4.10.2.3. Declaration of Pregnant Radiation Worker—Self-explanatory (module of the Personnel Information Change Request).

4.10.2.4. Administrative Dose Change—Used to change the dose reported by the TLD or to change a dose that was assigned as a result of an unreturned TLD.

4.10.2.5. Special Requests—Used to order additional whole body, neutron, and extremity dosimeters, hangers, clips, etc.

4.10.2.6. Request Cumulative Occupational Exposure History to Ionizing Radiation (AF Form 1527-2—For radiation workers assigned to your base or location. If the radiation worker is not currently assigned to your base/location, or if the worker was assigned within the last 5 days, you will not be able to generate an AF Form 1527-2 by using this service. This service is available interactively.

4.10.3. Routine Dosimetry Reports (1499-1, 1499-2, 1499-3)—These will be transmitted via the Radiation Dosimetry Web. Reports will be in PDF format and will be available for viewing and printing only. The USAF Center for Radiation Dosimetry will no longer send a hard copy of reports. Authorized users will receive email notification that a dose report is

ready for viewing and printing. *Reports will remain available for 30 days and then will automatically be deleted (reposts will be available upon request).*

4.10.4. Annual Dose Reports (AF Form 1527-1)—These reports also will be sent as described above.

4.10.5. The RDL Listing 1523 is now an electronic form available through the RDW. USAFSAM/OEA no longer accepts printed listings containing requested changes. All changes must be submitted via the RDW for timely processing and data integrity." (T-2)

Chapter 5

LOST, DAMAGED, OR NOT RECEIVED DOSIMETER PROCEDURES

5.1. General. On occasion, dosimeters may be lost, temporarily misplaced or damaged.

5.1.1. If a TLD is found to be lost or damaged at the end of monitoring period, the IRSO should explain the occurrence and assign an appropriate dose equivalent for the monitoring period using the Human Performance Wing Support (HPWS) Radiation Dosimetry Web (RDW) Administrative Dose Change (ADC) module. If the HPWS/RDW ADC module is not available, then the dose assignments may be made via a Memorandum For Record (MFR). The ADC may be submitted any time after the TLDs for the monitoring period have been returned to USAFSAM/OEA/DOSIMETRY.

5.1.2. If a TLD is not included in a received shipment from the field, USAFSAM/OEA assigns an interim administrative dose, sends a notification to the base, and requests that the TLD be returned immediately or that an evaluation be made to determine the appropriate dose equivalent that should be recorded for the monitoring period for the affected individual. Within 30 days of receipt, the IRSO must review these notices, assign an appropriate dose equivalent and report the dose equivalent to USAFSAM/OEA. (T-2) **Note: TLDs are used to measure the radiation exposure to AF personnel. All necessary steps should be taken to ensure security and accountability of TLDs shipped to your facility.**

5.2. Determining the Administrative Dose for Lost or Damaged TLDs or Dosimeters.

5.2.1. The following steps should be used in assigning an administrative dose:

5.2.1.1. The IRSO reviews radiation exposure records of the monitored individual and coworkers for the previous twelve months.

5.2.1.2. The first level supervisor prepares a statement of the worker's duties during the monitoring period and the worker signs the statement indicating concurrence.

5.2.1.3. The IRSO reviews the summary of duties and previous radiation exposures for the work area and assigns the best estimate of the dose equivalent using one of the following methods:

5.2.1.3.1. Occupancy or workload information and radiation dose levels at the radiation source operator location.

5.2.1.3.2. Data supplied by a supplemental dosimeter.

5.2.1.3.3. Average of the individual’s previous occupational dose for the preceding 6 to 12 months if conditions prevailed similar to those during the period for which the dose is being estimated.

5.2.1.3.4. Recorded doses accrued by coworkers performing similar duties under similar circumstances.

5.2.1.3.5. Established doses for specific unit, duty position, and mission (e.g. using Intrinsic Radiation [INRAD] data).

5.2.1.4. The IRSO can report the assigned doses to USAFSAM/OEA/DOSIMETRY by using the ADC module of the HPWS/RDW application (preferred method). The IRSO

may also report the assigned doses to USAFSAM/OEA/DOSIMETRY by MFR only if the HPWS/RDW is unavailable. If reporting via MFR, the report must include:

5.2.1.4.1. The assigned dose equivalent and any explanation on how that value was determined.

5.2.1.4.2. The dosimeter number, type of dosimeter and monitoring period.

5.2.1.4.3. The full name and full Social Security Number (SSN) of the individual. (T-2)

5.2.1.4.4. The signed statement of concurrence. If an individual chooses not to sign a statement of concurrence, the IRSO must note the reason. The individual will provide written comments to the IRSO in a reasonable time frame stating the rationale for non-concurrence. Copies of this report should be appropriately filed and/or a scanned copy should be included in the OHMIS. USAFSAM/OEA also will maintain a copy after the dose has been entered into the MRER as an assigned dose.

5.3. Dosimeters Not Received By USAFSAM/OEA. The TLD Program Monitor and the IRSO must attempt to locate the dosimeter. If found, the TLD or extremity dosimeter must be forwarded to USAFSAM/OEA with a note indicating that the dosimeter or TLD was previously not returned to USAF/OEA. If not found, follow the steps in the previous paragraph to assign the appropriate dose equivalent. If no response is received by USAFSAM/OEA within 30 days of the end of the monitoring period, a list of individuals who have not received a RSO assigned dose will be sent to MAJCOM BE and AFMSA/SG3PB for corrective actions.

Chapter 6

PERSONNEL MONITORING FOR PREGNANT RADIATION WORKERS

6.1. General. 10 CFR 20.1208 and AFI 48-148 require the dose equivalent to an unborn fetus as a result of occupational exposure of the mother be ALARA, not exceed 5 mSv (500 mrem) during the gestation period, and is recommended be limited to 0.5 mSv (50 mrem) per month. **Therefore, pregnant occupational radiation workers must be monitored monthly throughout their gestation period.** USAFSAM/OEA supports this requirement by providing monthly badges and priority processing and notification of dosimetry results for identified pregnant workers. If the person works in an area normally monitored quarterly, base program managers need to temporarily change her area registration to an area that is monitored monthly. In this case, storage of the dosimeter when not being worn must be kept with a monthly area control dosimeter. Otherwise the TLD may not get exchanged at the proper frequency or the area control will not be proper for the dosimeter. To obtain the most accurate results, both the control and the personnel monitor TLD need to be stored and processed together.

6.2. Installation Radiation Safety Officer (IRSO).

6.2.1. Evaluates the exposure potential for each pregnant worker and advises the attending physician accordingly.

6.2.2. Prescribes protective measures, including enrollment in the Dosimetry Program. Arranges placement on a monthly dosimetry exchange cycle and verifies priority processing of dosimetry by USAFSAM/OEA to ensure compliance with limits specified in paragraph 6.1.

6.2.3. Makes appropriate recommendation(s) regarding reassignment to a non-radiation work environment. Recommends work restrictions necessary to ensure adequate protection of the embryo/fetus. Assignment of pregnant workers to alternative duties for radiation protection purposes shall be without loss of all normal benefits associated with duties from which removed. Pregnant workers are normally removed from radiation related duties under the following circumstances:

6.2.3.1. Past monitoring (internal and external) indicates the worker will receive a whole body total effective dose equivalent (TEDE) of greater than 1 mSv (100 mrem) over the gestation period, or the potential for receiving this dose is unacceptably high.

6.2.3.2. Work directly involving unsealed radionuclides unless authorized in writing by AFMSA/SG3PB.

6.2.4. The IRSO notifies USAFSAM/OEA of pregnant occupational radiation workers requiring monthly monitoring and priority reporting of results.

6.2.4.1. This notification should be done by using the Radiation Dosimetry Web secure website.

6.2.4.2. If notification via the website is not possible, it should be made by facsimile.

6.2.4.2.1. Facsimile reporting must include the individual’s name, SSN, the installation and work area code, the estimated date of conception and whether or not the worker had any past history of external or internal radiation exposure.

6.2.4.2.2. Since the facsimile will contain personal and medical information such as SSN and medical conditions, the fax cover sheet must include the following disclaimer, "FOR OFFICIAL USE ONLY. This electronic transmission may contain personal medical information protected by the Privacy Act of 1974 (see AFI 33-332) and the Health Insurance Portability and Accountability Act (HIPAA) (see DoD 6025.18-R) not intended for disclosure outside government channels and exempt from mandatory disclosure under the Freedom of Information Act, 5 U.S.C., 552. Exemption 6 may apply. Do not release outside of DOD channels without the consent of the originator's office. If you received this message in error, please notify the sender either by reply email or phone, and delete all copies of this message."

Chapter 7

NON-ROUTINE DOSIMETRY

7.1. Radiation Workers on Extended Temporary Duty (TDY).

7.1.1. TDY for periods of 90 days or less.

7.1.1.1. Individuals going TDY for 90 days or less will take their dosimeter and a designated transit control dosimeter with them. The accompanying control dosimeter may be issued from spare dosimeters provided to the home base. **Note: TDY badges should be carried onto aircraft; checked baggage may be subject to x-ray radiation at a level that could inadvertently expose the TLDs and produce a measureable dose.**

7.1.1.2. Upon return from TDY, the individual will ensure the dosimeter and transit control are turned in for processing at the next exchange interval. In no instances will a dosimeter be kept for periods longer than 6 months.

7.1.2. TDY for Periods Exceeding 90 Days.

7.1.2.1. TDY/Deployed Locations Having an Established Dosimetry Program: While TDY to a location with an established Dosimetry Program, individuals will obtain necessary dosimetry at the TDY location. If dosimetry support is provided by other than USAFSAM/OEA, the individual is responsible for ensuring copies of their dosimetry results are provided to USAFSAM/OEA for inclusion in the MRER.

7.1.2.2. TDY/Within the Continental United States (CONUS): Locations Not Having an Established Dosimetry Program. Individuals on TDY for periods greater than 90 days to locations without an established dosimetry program will receive dosimetry support from their sponsoring organization for the duration of the TDY. Support will necessitate providing dosimetry controls and ensuring exchanges are made in a timely fashion. Gaining organizations anticipating ongoing requirements of this nature are encouraged to establish their own dosimetry programs.

7.1.2.3. TDY/ Outside the Continental United States (OCONUS): Locations Not Having an Established Dosimetry Program. Individuals on TDY for periods greater than 90 days to locations without an established dosimetry program will receive dosimetry support from the nearest location with an established dosimetry program. USAFSAM/OEA will provide additional dosimetry support to the location providing the support to these individuals. These procedures should be established before the member departs TDY for OCONUS locations.

7.2. Members or Employees of Other Services or Federal Agencies Who Are Occupationally Exposed to Ionizing Radiation From Air Force Operations.

7.2.1. Individuals employed by other military services or other federal agencies may on occasion be occupationally exposed to ionizing radiation while working under USAF jurisdiction. Examples of circumstances where this could occur include cooperative staffing of military MTFs, joint operations, etc.

7.2.2. Individuals having a primary employer other than the AF who are occupationally exposed while under USAF jurisdiction (i.e., while working with radiation sources subject to licensing, permitting, or control of the USAF) shall be enrolled in the Dosimetry Program and shall utilize USAF-provided personnel monitoring.

7.2.3. The MRER will maintain dosimetry results for individuals in circumstances of paragraph 7.2.4.

7.2.4. In addition, dosimetry results for these individuals will be reported to the individual's primary employer using procedures established between USAFSAM/OEA and the counterpart organization in the other federal agency.

7.2.5. USAFSAM/OEA will establish procedures to routinely request and obtain dosimetry results from the US Army and US Navy personnel dosimetry centers on any USAF personnel who have received personnel dosimetry services from those centers and will incorporate those results into the MRER as doses obtained outside the USAF.

7.3. Visitors (Occasionally-Exposed Individuals).

7.3.1. The IRSO may authorize visitors to enter a radiation area or high radiation area IAW AFI 48-148. Visitors entering defined "Radiation Areas" or "High Radiation Areas" or that are likely to incur a deep dose equivalent in excess of 0.1 mSv (10 mrem) shall be afforded personnel monitoring devices (see paragraph 1.5.3). The decision to provide either an EPD or TLD for entry into controlled areas should be based on the anticipated exposure potential during a single visit and the anticipated number of visits by an individual in a year. In no case shall a member of the public visiting controlled areas be permitted to receive a dose that exceeds the 1 mSv in a year (100 mrem in a year) limit of 10 CFR 20 and AFI 48-148. If EPDs are issued, the dosimeters must have been calibrated within the last year. In addition, a log of all direct reading dosimeter readings must be maintained by the workplace supervisor and include the following:

7.3.1.1. The date, time, and purpose of the visit.

7.3.1.2. The visitor's printed name, SSN, business address and phone.

7.3.1.3. The dosimeter's serial number and calibration date.

7.3.1.4. The dosimeter reading before and after the visit.

7.3.1.5. The dosimeter's net exposure reading and net exposure time.

7.3.2. The IRSO shall review all visitor dosimeter logs quarterly.

7.3.3. The IRSO shall ensure USAFSAM/OEA is provided a copy of all positive or greater than zero log readings for entry into the MRER within 10 calendar days of the end of the quarterly monitoring period.

7.3.4. Visitors shall not enter areas where unsealed radioactive materials are used and the use of respiratory protection is necessary to maintain exposures of visitors below 100 mrem TEDE.

7.4. Special Survey Dosimeters.

7.4.1. The IRSO may request special survey dosimeters (e.g., dosimeters used for area surveys, localized exposure determinations, conducting an exposure investigation) from USAFSAM/OEA.

7.4.2. Dosimeters routinely provided by USAFSAM/OEA will **not** be used for special surveys unless authorized by USAFSAM/OEA.

7.5. Planned Special Exposures (as defined in 10 CFR 20).

7.5.1. Planned special exposures will **not** be accomplished unless prior approval is granted by AFMSA/SG3PB. Requests for planned special exposures will be signed by the installation commander and include the following:

7.5.1.1. Justification for the planned special exposure.

7.5.1.2. Radiological Work Plan to include precautions to be taken to keep exposures received ALARA.

7.5.1.3. Name, SSN and cumulative record of lifetime radiation exposure history (NRC Form 4 or equivalent) for each individual involved.

7.5.2. Following approval by AFMSA/SG3PB, the IRSO notifies USAFSAM/OEA of the planned special exposure and provides the individual's name, SSN, work code and expected date of the planned exposure.

7.5.3. Upon being notified by the IRSO, USAFSAM/OEA:

7.5.3.1. Ensures individuals are entered into the Dosimetry Program.

7.5.3.2. Provides dosimeters specifically for use during the planned special exposure.

7.5.3.3. Provides AF Form 1527-2 for each individual before and after the planned special exposure.

7.5.3.4. USAFSAM/OEA provides priority processing of planned special exposure dosimeters and bioassay samples. USAFSAM/OEA provides consolidated external and internal results via facsimile to the IRSO, along with a new AF Form 1527-2.

7.5.3.5. The IRSO provides these results to all individuals involved in the planned special exposure within 15 calendar days of determining the dose.

7.6. Personnel Monitoring For U-2 Flight Operations.

7.6.1. **General**. U-2 training and mission operations routinely require pilots to fly at altitudes and for durations where doses from cosmic radiation become a significant source of exposure. Based upon flight studies conducted during training operations in 2012, and a following laboratory study with the Pacific Northwest National Laboratory, the European Organization for Nuclear Research (CERN), and the AF Radiation Dosimetry Laboratory, it has been determined that a specific monitoring program is required to accurately monitor and report pilot doses as a result of this unique exposure environment. USAFSAM/OEA supports this requirement by providing quarterly Thermo Scientific Mark N2 Electronic Personal Dosimeters (EPDs) issued directly to each pilot either in a training or operations environment. The EPD Mark N2 will be the sole dosimeter used to provide accredited monitoring of pilots. (T-2) To obtain the most accurate results each EPD Mark N2 assigned

to a pilot will be powered "ON" during pre-flight and then powered "OFF" once the flight is complete.

7.6.2. **Installation Radiation Safety Officer (IRSO).**

7.6.2.1. The IRSO notifies USAFSAM/OEA of each U-2 pilot attached to his/her installation and who require quarterly monitoring utilizing a Mark N2 EPD. If a U-2 pilot is deployed to certain locations without an existing IRSO, the IRSO, of the installation from which the U-2 pilot deployed from, will have responsibility of managing their dosimetry program. (T-2)

7.6.2.1.1. This notification should be done utilizing the Radiation Dosimetry Customer Support E-mail address (**USAFSAM.OEAL.Dosimet@us.af.mil**) utilizing the appropriate level of encryption for PII, Privacy Act and Health Insurance Portability and Accountability Act protected information.

7.6.2.1.1.1. The E-mail must include the individual's last name, first name, middle initial, SSN (complete), date of birth, and gender. (T-2)

7.6.2.1.2. If notification via the Radiation Dosimetry Customer Support E-mail is not possible, it should be made by facsimile.

7.6.2.1.2.1. Facsimile notification must include all the information listed in **7.6.2.1.1.1** above. (T-2)

7.6.2.1.2.2. Since the facsimile will contain personal information such as SSN and date of birth, the cover sheet must either be a DD Form 2923 or include the following disclaimer, "FOR OFFICIAL USE ONLY. This electronic transmission may contain personal medical information protected by the Privacy Act of 1974 (see AFI 33-332) and the Health Insurance Portability and Accountability Act (HIPAA) (see DoD 6025.18-R) not intended for disclosure outside government channels and exempt from mandatory disclosure under the Freedom of Information Act, 5 U.S.C., 552, Exemption 6 may apply. Do not release outside of DoD channels without the consent of the originator's office. (T-0) If you receive this message in error, please notify the sender either by E-mail or telephone, and destroy all copies of this message."

7.6.2.2. The IRSO shall be responsible for U-2 pilots attached to his/her installation and the distribution of EPD Mark N2 dosimeters assigned by the USAF Radiation Dosimetry Laboratory to appropriate personnel prior to the beginning of each monitoring period. (T-2) If a U-2 pilot is deployed to certain locations without an existing IRSO, the IRSO, of the installation from which the U-2 pilot deployed from, shall be responsible for the distribution of EPD Mark N2 dosimeters. (T-2)

7.6.2.3. The IRSO shall be responsible for the collection, packaging, and shipment of all EPD Mark N2 dosimeters for U-2 pilots attached to their installation. This shall be done for the previous monitoring period in accordance with section 1.4.6 of this manual. (T-2) If a U-2 pilot is deployed to certain locations without an existing IRSO, the IRSO, of the installation from which the U-2 pilot deployed from, shall be responsible for the collection, packaging, and shipment of all EPD Mark N2 dosimeters. (T-2)

7.6.2.4. The IRSO notifies USAFSAM/OEA when monitoring of any U-2 pilot attached to their installation is no longer necessary due to a change in occupation, separation or retirement. (T-2) If a U-2 pilot is deployed to certain locations without an existing IRSO, the IRSO, of the installation from which the U-2 pilot deployed from, shall notify USAFSAM/OEA. (T-2)

7.6.3. **Physiological Support Squadron (PSPTS)**

7.6.3.1. A PSPTS staff member will be responsible for ensuring the EPD Mark N2 assigned to a given pilot is powered "ON" and that the battery is viable prior to placing the device within the cockpit for each sortie. (T-3)

7.6.3.1.1. The EPD is powered "ON" by pressing and holding the single button located on the front of the EPD above the label for more than 2 seconds or until the EPD beeps and the display changes.

7.6.3.1.2. A low battery is indicated by a small "AA" shaped icon in the lower left of the display on the EPD. The battery should be replaced with another lithium ion (3.6 V) battery; however an alkaline AA will suffice for short-term operations. **NOTE: The use of an alkaline AA will require the battery to be removed at the end of each sortie to prevent battery rupture and subsequent damage to the EPD.**

7.6.3.1.2.1. The battery can be removed by using a US nickel placed into the slot on the battery cover located on the side of the EPD and gently rotating the cover 90 degrees counter-clockwise. It is important to not force the battery cover as this can damage the cover and/or the EPD.

7.6.3.1.2.2. The battery should then be removed from the EPD and disposed of IAW established procedures for the local installation.

7.6.3.1.2.3. Place a new battery within the EPD and reaffix the battery cover by reversing the steps listed above. Once the battery cover is replaced the EPD will begin the start-up sequence and run a full diagnostic of its operations (requires less than 30 seconds). If the EPD reports a fault, indicated by "F" followed by a number on the display, remove the battery, wait three minutes then replace. If the EPD repeats the fault contact the Radiation Dosimetry Laboratory for further instructions as soon as practicable.

7.6.3.2. The PSPTS staff member will secure the EPD Mark N2 within the cockpit in a manner that will not impair flight operations nor pose a health and safety risk to the pilot. (T-3) The EPD Mark N2 does NOT have to be affixed/secured to the pilot.

7.6.3.3. Post sortie a PSPTS staff member will be responsible for removing the EPD Mark N2 from its storage location within the cockpit and for turning the unit "OFF". (T-3) **NOTE: This includes removing the battery if an alkaline AA is being used.**

7.6.3.3.1. The EPD is powered "OFF" by pressing and holding the single button located on the front of the EPD above the label until the display reads, "OFF".

7.6.3.3.2. The user then double presses the same button; the word "OFF" should begin flashing.

7.6.3.3.3. Before the word "OFF" stops flashing the user must double press the button again, the word "OFF" should then remain on the screen (not flashing). The EPD will no longer record dose information until turned "ON" again.

7.6.4. **AF Radiation Dosimetry Laboratory (RDL)**

7.6.4.1. USAFSAM/OEA Radiation Dosimetry will provide calibrated EPD Mark N2 devices to all required IRSOs on a quarterly basis for the purposes of monitoring all U-2 pilots for occupational exposure to radiation. (T-2)

7.6.4.1.1. All EPD Mark N2 devices will have a calibration and "Due Date" which will be indicated on the AFTO Form 394 attached to each device.

7.6.4.1.1.1. The calibration date shall be such that the device will remain within calibration throughout the monitoring period.

7.6.4.1.1.2. The Due Date will be the date the EPD is expected to be returned to the RDL for dose processing.

7.6.4.1.2. The AFTO Form 394 will indicate the pilot's first and last name for assignment purposes. An EPD assigned to one pilot cannot be used to monitor another individual if a pilot has left the career field or separated/retired from the AF and no longer requires monitoring the EPD should be returned to USAFSAM/OEA as soon as possible. (T-1)

7.6.4.2. USAFSAM/OEA Radiation Dosimetry shall ensure that the demographical information for each pilot is correctly entered into the WebREMS EPD software application for the issue and dose read of all EPD Mark N2 devices assigned to U-2 pilots. (T-2)

7.6.4.3. USAFSAM/OEA Radiation Dosimetry shall ensure that all dose records from U-2 pilot monitoring will be entered into the AF Master Radiation Exposure Registry IAW established and accredited procedures. (T-2)

7.6.4.3.1. Monitoring period dose reports will be uploaded to the Radiation Dosimetry Web secure site for retrieval by IRSOs, who have U-2 pilots attached to their installation. If a U-2 pilot is deployed to certain locations without an existing IRSO, the IRSO, of the installation from which the U-2 pilot deployed from, shall be responsible for retrieving dose reports. (T-2)

7.6.4.3.2. All U-2 pilot doses will be included in the Annual Occupational Exposure History to Ionizing Radiation (AF Form 1527-1) report provided to the IRSO by 31 March of the next calendar year. (T-2)

7.6.4.4. USAFSAM/OEA Radiation Dosimetry will provide consultative support for this specific monitoring program as needed. (T-2)

Chapter 8

ABNORMAL EXPOSURES

8.1. Abnormal Exposures. Any dosimeter and/or bioassay result exceeding any of the values in Table 8.1 represent an "abnormal exposure."

Table 8.1. Abnormal Exposure Criteria.

The More Restrictive Of	Value	
	Monthly Dosimeter	Quarterly Dosimeter
Total Effective Dose Equivalent	>4.17 mSv (0.417 rem)	> 12.5 mSv (1.25 rem)
Deep dose equivalent to pregnant radiation worker	> 0.5 mSv (0.05 rem)	N/A
Sum of deep dose equivalent and committed dose equivalent to any individual organ or tissue other than the lens of the eye	> 41.7 mSv (4.17 rem)	> 125 mSv (12.5 rem)
Eye dose equivalent	> 12.5 mSv (1.25 rem)	> 37.5 mSv (3.75 rem)
Shallow dose equivalent to skin or extremity	> 41.7 mSv (4.17 rem)	> 125 mSv (12.5 rem)
Internal deposition of any radionuclide	>10% of ALI	>25% of ALI

8.2. Abnormal Exposure Suspected by Base. Any dosimeter suspected of receiving an abnormal exposure will be forwarded to USAFSAM/OEA together with a control dosimeter and an identifying letter detailing the circumstances involved in the suspected exposure. The control dosimeter should be taken from that monitoring period's unused stock of extras unless the exposure is believed to have occurred while the dosimeter was stored in its normal location on a rack with the standard control dosimeter. Whenever an abnormal exposure is suspected, the standard control dosimeter will be submitted along with the suspected exposed dosimeter and a control dosimeter from that monitoring period's unused stock of extras and the standard control dosimeter replaced from the unused stock of extras. If you have no unused stock of dosimeters, contact USAFSAM/OEA for further instructions. Suspected abnormally exposed TLDs will receive priority processing at USAFSAM/OEA and the dose results will be reported back to the IRSO as soon as they are available.

8.3. Abnormal Exposure Observed by USAFSAM/OEA Upon Processing a Dosimeter. The IRSO is to conduct an investigation into the abnormal exposure and submit a written report within 30 calendar days on the findings of the investigation, IAW AFI 48-148. Finalized reports must be sent to USAFSAM/OEA and the MAJCOM BE. An advance copy of the investigation report should be sent to the MAJCOM BE as well as USAFSAM/OEA.

8.4. Notification of Abnormal Exposures.

8.4.1. USAFSAM/OEA notifies the installation IRSO by telephone, within 72 hours, and follows-up with a facsimile memorandum of apparent abnormal exposures. The memorandum:

8.4.1.1. Identifies the dosimeter and/or bioassay sample number.

8.4.1.2. Includes the name, SSN, and occupational code of the individual involved.

8.4.1.3. Gives a dose equivalent estimate based on the dosimeter results, bioassay concentrations, or both.

8.4.1.4. Provides instructions to accomplish the required investigation IAW AFI 48-148.

8.5. Exception. When an assigned dosimeter is not returned to USAFSAM/OEA, an Administrative Dose equal to the corresponding dose in Table 8-1, is automatically assigned for the given exchange frequency. These doses are not a valid representation of the individual's exposure and therefore will not be treated as an abnormal exposure. The sole purpose of these types of dose assessments is to notify IRSOs that actions must be taken to correct the individual's records to more accurately reflect personnel exposure.

8.6. Investigation. The IRSO must initiate a formal investigation for abnormal exposures to ensure personnel that the IRSO, MAJCOM BE, and USAFSAM/OEA are aware of **ANY** actual abnormal occupational exposure and take corrective actions as necessary to avoid exceeding annual occupational limits. **Note: Other investigations may be indicated, see investigation action level definition in the glossary.**

8.6.1. Circumstances surrounding the abnormal exposure.

8.6.2. The validity of the dose received.

8.6.3. The portion of the body exposed.

8.6.4. Any corrective actions required preventing recurrence.

8.7. Written Report.

8.7.1. The IRSO submits a written report on the findings of the investigation to USAFSAM/OEA and the MAJCOM BE within 30 calendar days of being notified about the possible abnormal exposure. The report includes:

8.7.1.1. Name, SSN, occupational code, and AFSC of the individual involved.

8.7.1.2. Description of circumstances surrounding the abnormal exposure.

8.7.1.3. Estimates of each individual's dose equivalent to include a detailed discussion of how this value was determined.

8.7.1.4. If it is determined that the individual's dosimeter was inadvertently exposed to radiation while not being worn, the following information needs to be determined to assist in estimating the appropriate dose to be assigned for this monitoring period:

8.7.1.4.1. During the monitoring period, did the individual's activities differ from normal activities or those of fellow workers during the same monitoring period? If so, in what way did they differ (e.g., did the workload increase or decrease significantly)?

8.7.1.4.2. Was the individual involved in any activities, which might have caused the dosimeter to indicate a higher or lower dose than normal?

8.7.1.4.3. If the individual wore pocket dosimeters, what was the indicated exposure during the monitoring period?

8.7.1.4.4. What is the individual's past dose history?

8.7.1.4.5. What dose did the individual receive during normal periods of work?

8.7.1.4.6. Provide any available evidence used in concluding the investigation. The letter could potentially be used for medical and legal purposes so, therefore, must be complete.

8.7.1.4.7. Corrective actions taken to prevent recurrence. Appropriate corrective actions might include: Instruction on the proper wear and uses of the dosimeter, ensuring the adequacy of the radiation protection program, surveying and correcting faulty equipment, moving the dosimeter storage area to an area free of radiation sources, etc.

8.7.1.4.8. Statement signed by the individual involved either supporting or contesting the investigation report.

8.7.1.4.9. Results of any medical examinations (if appropriate).

8.7.2. USAFSAM/OEA evaluates the written report and requests any additional information from the IRSO as may be necessary to fully document the dose received and updates the MRER. Upon notification by USAFSAM/OEA that the MRER has been updated the IRSO should acquire an AF Form 1527-2 for the individual in question or request one from USAFSAM/OEA. USAFSAM/OEA retains all supporting documentation for the dose assigned.

8.7.3. The IRSO will ensure copies of reports validating the occurrence of an abnormal exposure are forwarded to AFMSA/SG3PB and to the applicable MAJCOM BE.

8.7.4. USAFSAM/OEA ensures the MRER is updated accordingly.

8.8. Termination of Investigation. USAFSAM/OEA will review reports involving doses considered as abnormal. AFMSA/SG3PB evaluates the reports of abnormal exposure and either approves termination of the incident or requests additional information. Following termination, USAFSAM/OEA updates the MRER. Upon notification by USAFSAM/OEA that the MRER has been updated the IRSO should acquire an AF Form 1527-2 for the individual in question or request one from USAFSAM/OEA. The IRSO ensures the individual is given a copy of the revised AF Form 1527-2.

Chapter 9

POTENTIAL OVEREXPOSURES

9.1. General. Any dosimeter and/or bioassay result that exceeds the applicable dose limits specified in 10 CFR 20 and/or AFI 48-148 shall be considered to represent a "potential overexposure".

Table 9.1. Potential Overexposure Criteria.

The More Restrictive Of	Value
Total Effective Dose Equivalent	> 0.05 Sv (5.0 rem)
Total effective dose equivalent to pregnant radiation worker during course of pregnancy	> 0.005 Sv (0.500 rem)
Sum of deep dose equivalent and committed dose equivalent to any individual organ or tissue other than the lens of the eye	> 0.5 Sv (50 rem)
Eye dose equivalent	> 0.15 Sv (15 rem)
Shallow dose equivalent to skin or extremity	> 0.5 Sv (50 rem)
Internal deposition of any radionuclide	> applicable ALI

9.2. Potential Overexposure Identified by Base.

9.2.1. An IRSO who is notified by an individual, or suspects a potential overexposure may have occurred, immediately notifies USAFSAM/OEA, the MAJCOM BE and AFMSA/SG3PB by telephone and follows-up with a letter (facsimile or scanned/emailed) explaining the circumstances. This includes, but is not limited to, potential overexposures as a result of radiological or nuclear accidents or incidents, both garrison or deployed.

9.2.2. Following notification by the IRSO, USAFSAM/OEA immediately provides an encrypted E-mail or facsimile instructions for performing an investigation, to include any bioassay requirements, and requests the IRSO return any dosimeters and (or) bioassays in progress at the time immediately to USAFSAM/OEA for priority processing.

9.2.3. USAFSAM/OEA provides priority processing for all bioassay samples collected in overexposure investigations and immediately reports the results to the IRSO by telephone and facsimile letter.

9.2.4. Written Report: The IRSO provides a written report of the investigation findings through the MAJCOM BE to USAFSAM/OEA within seven (7) calendar days of being notified of the potential over exposure. Copies of this report are provided to AFMSA/SG3PB and the individual.

9.3. Removal from Duties. Individuals that have possibly received an overexposure will be removed from duties involving radiation exposure as recommended by the IRSO to the individual's supervisor, pending completion of the final investigation report. This removal from duty is not to be considered adverse personnel action. If the final investigation report concludes the individual received an overexposure, AFMSA/SG3PB concurrence must be obtained before the exposed individual is allowed to return to radiation related duties.

9.4. Potential Overexposure Identified by USAFSAM.

9.4.1. Notification.

9.4.1.1. When a dosimeter or bioassay indicates an overexposure may have occurred, USAFSAM/OEA immediately notifies the IRSO by telephone and follows with an encrypted E-mail or facsimile letter within two (2) hours. Facsimile copies of this letter are provided to AFMSA/SG3PB.

9.4.1.2. Following telephone notification by USAFSAM/OEA, the IRSO immediately contacts the unit commander and requests the individual be removed from all duties involving potential radiation exposure until an investigation of the incident can be completed. The IRSO also notifies the MTF commander who, in turn, notifies the installation commander, as appropriate. Notification should also be made to the appropriate MAJCOM BE.

9.4.2. Investigation. The IRSO investigates suspected overexposures in the same manner as abnormal exposures (see paragraph 8.6). An overexposure may represent a potentially or overtly injurious dose of ionizing radiation. These investigations demand swift action, more detailed reporting procedures, possible medical follow-up and comprehensive documentation.

9.4.3. Written Report. The IRSO provides a written report of the investigation findings through the MAJCOM BE to USAFSAM/OEA within seven (7) calendar days of being notified of the potential over exposure. Copies of this report are provided to AFMSA/SG3PB. All reports should include the following information:

9.4.3.1. Name, SSN, occupational code and AFSC of individual involved.

9.4.3.2. Description of circumstances surrounding the potential overexposure.

9.4.3.3. Estimates of each individual's total effective dose equivalent to include a detailed discussion of how this value was determined.

9.4.3.4. Root cause of the exposure: Factors to be considered might include; deliberate exposure of the dosimeters, dosimeter worn while the individual concerned received diagnostic or therapeutic radiation exposure as a patient, improper action on the part of the individual in question, inadequate protective measures, faulty operation of equipment, or use of the dosimeter for other than personnel monitoring, etc.

9.4.3.5. If it is determined that the individual's dosimeter is erroneous, for whatever reason, the following information should be considered in estimating the appropriate administrative dose to be assigned for the monitoring period. The report should provide any evidence available used in developing this estimate.

9.4.3.5.1. During the monitoring period, did the individual's activities differ from normal activities or those of fellow workers during the same monitoring period? If so, in what way did they differ (e.g., did the workload increase or decrease significantly)?

9.4.3.5.2. Was the individual involved in any activities, which might have caused the dosimeter to indicate a higher or lower dose than normal?

9.4.3.5.3. What is the individual's past dose history?

9.4.3.5.4. What dose did the individual receive during normal periods of work?

9.4.3.5.5. Corrective actions taken to prevent recurrence. Appropriate corrective actions might include; instruction on the proper wear and uses of dosimeters, ensuring the adequacy of the radiation protection program, surveying and correcting faulty equipment, moving the dosimeter storage area to an area free of radiation sources, etc.

9.4.3.5.6. Statement signed by the individual involved either supporting or contesting the investigation report.

9.4.3.5.7. Results of any medical examinations (if appropriate).

9.5. Termination of Investigation. USAFSAM/OEA will review reports involving doses considered potential or true overexposure. AF RSC evaluates the reports of potential overexposures and either approves termination of the incident or requests additional information. (T-2) Following termination, USAFSAM/OEA updates the MRER. Upon notification by USAFSAM/OEA that the MRER has been updated the IRSO should acquire an AF Form 1527-2 for the individual in question or request one from USAFSAM/OEA. The IRSO ensures the individual is given a copy of the revised AF Form 1527-2.

Chapter 10

WEIGHTED EFFECTIVE DOSE EQUIVALENT (EDE) WHEN SHIELDED PROTECTIVE APRON IS WORN

10.1. Applicable Population. Occupational radiation workers certified by the IRSO as working exclusively with radiation sources not subject to regulation of the NRC, and wearing both a whole body badge beneath shielded protective clothing and a collar badge worn outside the shielded protective clothing.

10.2. General Protocol. Fluoroscopy procedures are the largest source of occupational radiation dose in medicine. Fluoroscopic and special procedures may account for 90% of the total collective dose accrued by occupationally exposed persons working in general radiography. The radiation dose to personnel performing these procedures is non-uniform, with relatively high doses to the head, neck, and extremities, with much lower doses to the trunk and other regions protected by shielding (lead aprons). A special calculation protocol is necessary to provide a more realistic estimate of the effective dose received by individuals working in these highly specialized radiographic/fluoroscopic work environments. Numerous approaches and models have been proposed to address the issue that the DDE recorded for personnel during such procedures by a single monitoring badge worn on the neck above an apron will overestimate the effective dose equivalent (H_E) by factors of 8 to 23, while a single monitoring badge worn at the waist under an apron will underestimate H_E by factors of 1.2 to 60. For x-rays having energies within the kilovoltage range commonly used in diagnostic radiology (60 to 120 kVp), the calculated values of H_E range from 0.93 to 0.95 for 0.5 mm lead aprons and from 0.99 to 1.48 H_E for 0.3 mm lead aprons. This approximation is given by:

$$EDE = (1.5 \times WB) + (0.04 \times WBCL)$$

Where:

EDE = Effective Dose Equivalent

WB = Dose measured by the whole body badge worn **under** the lead apron

WBCL = Dose measured by the whole body badge worn on the collar, **outside** the lead apron

10.3. Applicability Criteria. Weighting DDE may be applied if **all** of the following conditions are met:

10.3.1. During the monitoring period, the individual works **only** with machine produced radiation sources.

10.3.2. During the monitoring period, the individual **never** works with radiation sources regulated by the NRC, radioactive material permitted under the USAF Radioisotope Committee, Section 91b radioactive materials permitted by HQ AFMC, or exposures from intrinsic radiation from nuclear weapons.

10.3.3. During the monitoring period, the individual is **not** enrolled in the pregnant radiation worker-monitoring program (generally indicated as “Area PF” by the IRSO).

10.3.4. The whole body badge is worn on the front of the body, below the neck and above the waist, underneath the lead apron.

10.3.5. The collar badge is worn on the front of the body, at collar or neck level, outside the lead apron.

10.3.6. Placement of the two badges is not interchanged during the monitoring period.

10.3.7. If **any** of the above conditions are **not** met, the dose of record is the highest dose recorded for any dosimeter during that monitoring period.

10.4. Example of Dose Recording. When weighting is applied, the results obtained from both badges must be recorded on the individual's dose record together with the calculated EDE. However, only the calculated EDE is added to the cumulative deep dose total for the quarter, year to date, or lifetime. An example of the application of this weighting protocol is shown in the following table:

Table 10.1. Sample of Weighting Calculation.

Dosimeter	Deep Dose Equivalent	Lens Dose Equivalent	Shallow Dose Equivalent
Type	mSv (rem)	mSv (rem)	mSv (rem)
Chest Badge	0.2 (0.020)	0.2 (0.020)	0.25 (0.025)
Collar Badge	2.5 (0.250)	2.6 (0.260)	2.75 (0.275)
*$EDE_{(Calc.)}$	0.4 (0.040)	-	-
*$EDE_{(Calc)}$ = (1.5 X Deep(chest)) + (0.04 X Deep (collar)) In this example, the dose equivalent of record for Deep, Lens and Shallow are 0.4 mSv (0.040 rem), 2.6 mSv (0.260 rem) and 2.75 mSv (0.275 rem), respectively, because the weighting calculation applies only to deep dose equivalent.			

Chapter 11

FORMS, LISTINGS, RECORDS AND REPORTS

11.1. General.

11.1.1. USAF Master Radiation Exposure Registry (MRER). The MRER provides a centralized, permanent record of exposure for all personnel currently and previously registered in the Dosimetry Program (See Chapter 12 for a detailed description of the MRER). The information contained in the MRER serves as the source for the generation of dose equivalent reports to be included in an individual's medical records. The MRER is medical information and contains Privacy Act information that must be protected in accordance with AFI 33-332, Privacy Act Program Records Maintenance: All records of exposure to ionizing radiation (e.g., RDL Listing 14991, RDL Listing 14992, AF Form 1527) are to be maintained in accordance with this manual, the requirements of 10 CFR 20.2106, DODI 6055.8, AFI 48-148 and HPS N13.6-1999.

11.1.2. RDL Listing 1523, Dosimetry Assignment Data. Serves as a shipping list of dosimeters provided to a base for a specified monitoring period. It is automatically prepared based on information provided to USAFSAM/OEA by the IRSO for individuals and areas. Information included on the RDL Listing 1523 includes:

Figure 11.1. RDL Listing 1523, Dosimetry Assignment Data.

02/16/2000 **Dosimetry Assignment Data** 7 of 9

This form is covered by the privacy act statement as given in DD Form 2005

Base: 0253 **Area:** R RADIATION DOSIMETRY BRANCH
HUMAN SYSTEMS CENTER/EMB

2909 NORTH ROAD
BROOKS AFB TX 78235-5336

For The Period Of: 10/01/1999
To: 12/31/1999

Name	SSN	Dob	Sex	OCC	Pack ID#	Badge Id	Wear Loc	Start Date	Collection Date	Remarks: Add/Del/Change
RADIATION	CONTROL-B					0506968	CNTL	10/1/99	12/31/99	
	CONTROL-N					0505999	CNTL	10/1/99	12/31/99	
				097	12756	0520923	BODY	10/1/99	12/31/99	
				097	12756	0530047	NBOD	10/1/99	12/31/99	
				097	12757	0536402	BODY	10/1/99	12/31/99	
				097	12757	0517845	NBOD	10/1/99	12/31/99	
				089	12758	9407671	BODY	10/1/99	12/31/99	
				089	12758	0514136	NBOD	10/1/99	12/31/99	
				097	12759	0509567	BODY	10/1/99	12/31/99	
				097	12759	0511777	NBOD	10/1/99	12/31/99	
				097	12760	9413788	BODY	10/1/99	12/31/99	
				097	12760	0519862	NBOD	10/1/99	12/31/99	
				097	12761	9119553	BODY	10/1/99	12/31/99	
				097	12761	9115403	NBOD	10/1/99	12/31/99	
				097		0509197	NBOD	10/1/99	12/31/99	
				097		0517370	BODY	10/1/99	12/31/99	

11.1.2.1. **Date Prepared:** The date the listing was prepared (shown in the upper left corner of each page).

11.1.2.2. **Page # of #:** The page number and total number of pages in the listing (each area begins on a separate page).

11.1.2.3. **Base Code/Client Code:** A unique alpha-numeric code, established to identify each base.

11.1.2.4. **Area:** The designation of the monitoring area for data included on this report. This can be up-to two characters and is established by the IRSO, except that a separate area identified as "PF" is reserved for pregnant radiation workers. This listing shows the two character abbreviation and the plain-text description of the area as provided by the IRSO.

11.1.2.5. **For the Period of:** The normal starting date for use of the dosimeters included in this shipment. Dosimeters should not be used before the indicated start date without the specific permission of USAFSAM/OEA. Unless specifically indicated by the IRSO in the details section, it will be presumed that the individual to whom the dosimeter is issued began wearing the dosimeter on this date.

11.1.2.6. **To:** The normal ending date for dosimeters use is included in the shipment. Dosimeters should not be used beyond the indicated ending date without specific permission of USAFSAM/OEA. Unless specifically indicated by the IRSO in the details section, it will be presumed that the individual to whom the dosimeter is issued discontinued wearing the dosimeter on this date.

11.1.2.7. **Name:** Name of individual to whom the dosimeter is to be issued (or other special designator such as "spare," "control," etc.).

11.1.2.8. **SSN:** The SSN of the individual to whom the dosimeter is to be issued. When the dosimeter is to be used as a "control," this field will read "CONTROL-B" (whole body), "CONTROL-N" (neutron), or "CONTROL-F" (ring).

11.1.2.9. **DOB:** Date of birth of the individual to whom the dosimeter is to be issued.

11.1.2.10. **Sex:** Gender of the individual to whom the dosimeter is to be issued.

11.1.2.11. **OCC Code:** The three-character occupation code describing the type of occupational radiation exposure (Attachment 4 to this manual is a listing of Occupation Codes).

11.1.2.12. **Pack ID #:** A control number assigned by USAFSAM/OEA to uniquely identify the dosimeter(s) to be assigned to each individual.

11.1.2.13. **Badge ID:** The unique numeric identification number shown on each dosimeter to be assigned to an individual.

11.1.2.14. **Wear LOC:** Wear location for this dosimeter.

11.1.2.14.1. CNTL=Control Dosimeter

11.1.2.14.2. BODY=Whole Body

11.1.2.14.3. NBOD=Neutron Whole Body

11.1.2.14.4. COLL=Collar Dosimeter

11.1.2.14.5. RING=Extremity Dosimeter (ring)

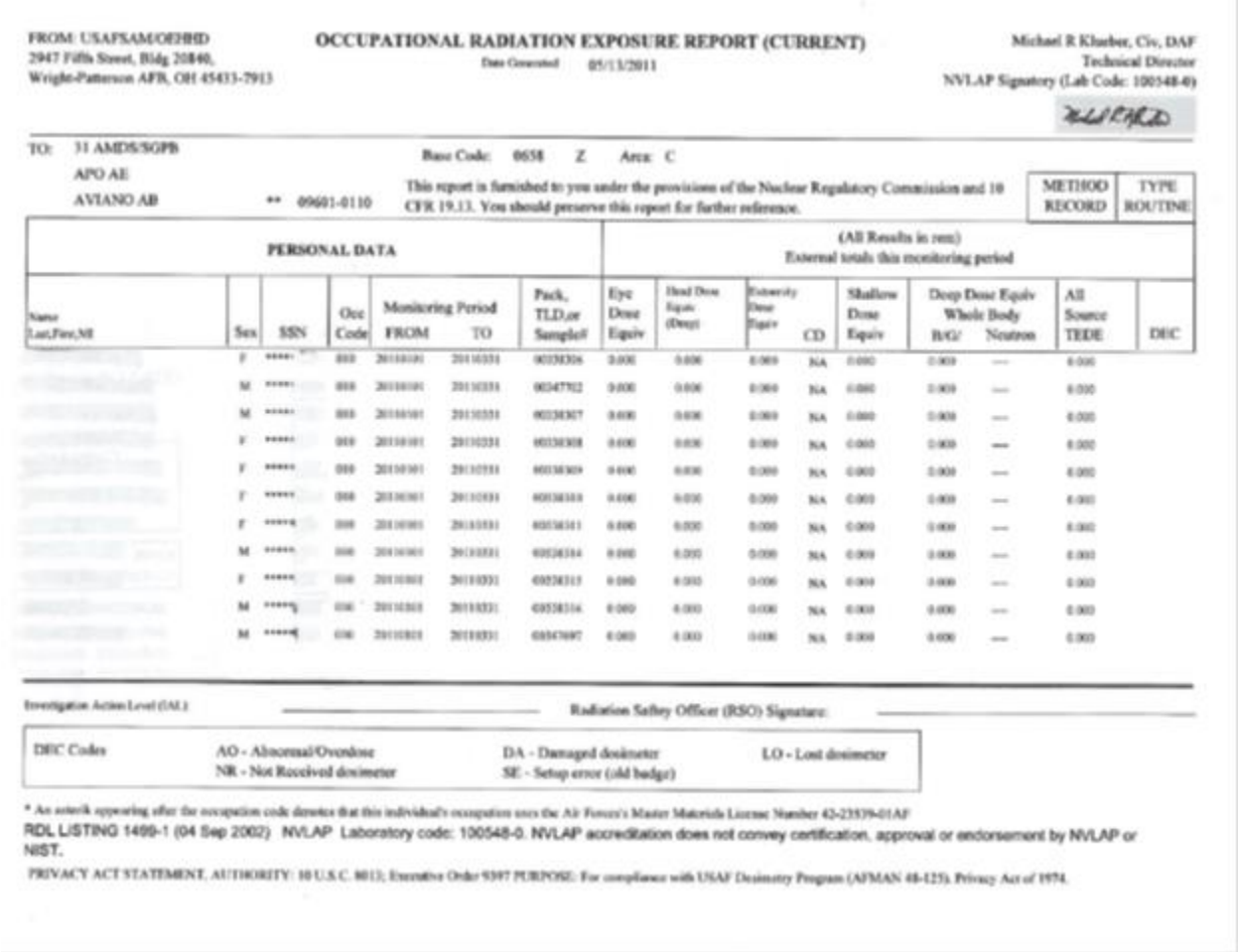
11.1.2.15. **Start Date (MM/DD/YY):** The date the dosimeter is issued by the IRSO to the individual being monitored. If all dosimeters are issued on the same day, one entry with a line down to the bottom of the listing will be adequate. When adding an individual to the program, the date the individual is issued the dosimeter must be indicated.

11.1.2.16. **End Date:** The date the dosimeter is collected by the IRSO from the individual being monitored. At the end of the monitoring period, there should be an entry for each dosimeter that is issued and collected. As the dosimeters are collected, place a check next to the date collected to confirm receipt.

11.1.2.17. **Remarks: (Add/Del/Change):** On the form, indicate any action required by USAFSAM/ OEA to be taken. If adding an individual to the program, write "ADD" in this column. Ensure that the AREA in which the individual needs to be added is also included in comment. (i.e., ADD to Area PF). If deleting an individual from the program, there are two possible entries for this column. If the individual has worn the TLD during the monitoring period, specify “DELETE/WORN (DW)” in this column. If the individual has **not** worn the TLDs during this period, indicate “DELETE/NOT WORN (DNW)” in this column. If any personnel or dosimetry data must be changed, write "CHANGE" in this column, along with the proper information that the change needs to reflect (e.g., “CHANGE” last name to Doe). This field is also used to indicate anything that may be pertinent for the records of the individual being monitored. For example, if the dosimeter was not returned, write "NOT RETURNED," "TDY," "LOST," etc. in this column. If the monitoring was for a visitor (e.g., one time monitoring), write "ONE TIME" in this column. If the individual is deleted from the program due to a permanent change of station, write "PCS" in this column.

11.1.3. RDL Listing 1499-1, Current Occupational Radiation Exposure Report. This listing serves as a summary report for USAFSAM/OEA issued dosimetry. The automated record shows the results for all individuals assigned to a given base code and area. Information included on the RDL Listing 1499-1 includes:

Figure 11.2. RDL Listing 1499-1.



FROM: USAFSAM/OEHHD
2947 Fifth Street, Bldg 20840,
Wright-Patterson AFB, OH 45433-7913

OCCUPATIONAL RADIATION EXPOSURE REPORT (CURRENT)
Date Generated 05/13/2011

Michael R Klueber, Civ, DAF
Technical Director
NVLAP Signatory (Lab Code: 100548-0)

TO: 31 AMDS/SGPB
APO AE
AVIANO AB ** 09601-0110

Base Code: 0658 Z Area: C

This report is furnished to you under the provisions of the Nuclear Regulatory Commission and 10 CFR 19.13. You should preserve this report for further reference.

METHOD	TYPE
RECORD	ROUTINE

PERSONAL DATA							(All Results in rem) External totals this monitoring period								
Name Last,First,MI	Sex	SSN	Occ Code	Monitoring Period FROM	TO	Pack, TLD,or Sample#	Eye Dose Equiv	Shal Dose Equiv (Deep)	Extremity Dose Equiv	CD	Shallow Dose Equiv	Deep Dose Equiv Whole Body B/G	Neutron	All Source TEDE	DEC
	F	*****	010	20100101	20101031	00295326	0.000	0.000	0.000	NA	0.000	0.000	---	0.000	
	M	*****	010	20100101	20101031	00247702	0.000	0.000	0.000	NA	0.000	0.000	---	0.000	
	M	*****	010	20100101	20101031	00238307	0.000	0.000	0.000	NA	0.000	0.000	---	0.000	
	F	*****	010	20100101	20101031	00238308	0.000	0.000	0.000	NA	0.000	0.000	---	0.000	
	F	*****	010	20100101	20101031	00238309	0.000	0.000	0.000	NA	0.000	0.000	---	0.000	
	F	*****	010	20100101	20101031	00238310	0.000	0.000	0.000	NA	0.000	0.000	---	0.000	
	F	*****	010	20100101	20101031	00238311	0.000	0.000	0.000	NA	0.000	0.000	---	0.000	
	M	*****	010	20100101	20101031	00238314	0.000	0.000	0.000	NA	0.000	0.000	---	0.000	
	F	*****	010	20100101	20101031	00238315	0.000	0.000	0.000	NA	0.000	0.000	---	0.000	
	M	*****	010	20100101	20101031	00238316	0.000	0.000	0.000	NA	0.000	0.000	---	0.000	
	M	*****	010	20100101	20101031	00247697	0.000	0.000	0.000	NA	0.000	0.000	---	0.000	

Investigation Action Level (IAL) _____ Radiation Safety Officer (RSO) Signature: _____

DEC Codes			
	AO - Abnormal/Overdose	DA - Damaged dosimeter	LO - Lost dosimeter
	NR - Not Received dosimeter	SE - Setup error (old badge)	

* An asterik appearing after the occupation code denotes that this individual's occupation uses the Air Force's Master Materials License Number 42-23539-01AF

RDL LISTING 1499-1 (04 Sep 2002) NVLAP Laboratory code: 100548-0. NVLAP accreditation does not convey certification, approval or endorsement by NVLAP or NIST.

PRIVACY ACT STATEMENT. AUTHORITY: 10 U.S.C. 8013; Executive Order 9397 PURPOSE: For compliance with USAF Dosimetry Program (AFMAN 48-125). Privacy Act of 1974.

11.1.3.1. **TO:** The mailing address for the base code and area.

11.1.3.2. **BASE CODE/CLIENT CODE:** A unique alpha-numeric code, established to identify each base.

11.1.3.3. **AREA:** The designation of the monitoring area for data included on this report. This can be up-to two characters and is established by the IRSO, except that a separate area identified as "PF" is reserved for pregnant radiation workers.

11.1.3.4. **METHOD:** How the results in this report were determined – **RECORD** for results measured from reading dosimeters or **CALC** for results calculated from other data such as a dose estimate report prepared by the IRSO.

11.1.3.5. **TYPE:** Type of exposure – **ROUTINE** for regular monitoring cycle, **SPECIAL** for dosimeters processed outside the normal monitoring cycle as might occur in the case of a suspected abnormal exposure, potential overexposure or for a planned special exposure.

11.1.3.6. PERSONAL DATA:

11.1.3.6.1. **NAME (Last, First, MI):** The name of the individual to whom the dosimeter is assigned.

11.1.3.6.2. **SEX:** Gender of the individual to whom the dosimeter is assigned.

11.1.3.6.3. **SSN:** The social security number of the individual to whom the dosimeter is assigned.

11.1.3.6.4. **OCC CODE:** The three-character occupation code describing the type of occupational radiation exposure. Reported results should be compared with the AF-wide summary by OCC Code to verify that an individual's exposure remains within the established ALARA constraints.

11.1.3.7. **MONITORING PERIOD (FROM, TO):** The start and end dates the dosimeter is assigned to an individual (YYYYMMDD).

11.1.3.8. **PACK, TLD, OR SAMPLE #:** A unique number identifying the physical dosimeter assigned to the individual during the monitoring period.

11.1.3.9. **EXTERNAL TOTALS THIS MONITORING PERIOD (ALL RESULTS IN REM):** The results measured from processing the dosimeters assigned to each individual.

11.1.3.9.1. **EYE DOSE EQUIV:** Absorbed dose (rem) from radiation of sufficient energy to penetrate an absorber providing attenuation equivalent to 300 mg/cm^2 (equivalent to the approximate density thickness of the cornea and aqueous humor).

11.1.3.9.2. **HEAD DOSE EQUIV (DEEP):** Absorbed dose (rem) to the head, neck, and thyroid from radiation of sufficient energy to penetrate an absorber providing attenuation equivalent to 1,000 mg/cm^2 (i.e., sufficient to reach deep tissue and blood forming organs such as bone marrow).

11.1.3.9.3. **EXTREM DOSE EQUIV:** The absorbed dose (rem) to the maximally exposed extremity (hands and forearms) from radiation of sufficient energy to penetrate an absorber providing attenuation equivalent to 7 mg/cm^2 (approximately that afforded by the dead layer of the skin).

11.1.3.9.4. **SHALLOW DOSE EQUIV:** The absorbed dose (rem) to the skin of the whole body from radiation of sufficient energy to penetrate an absorber providing attenuation equivalent to 7 mg/cm^2 (approximately that afforded by the dead layer of the skin).

11.1.3.9.5. **DEEP DOSE EQUIV:** The absorbed dose (rem) to the whole body from radiation of sufficient energy to penetrate an absorber providing attenuation equivalent to 1,000 mg/cm^2 (i.e., sufficient to reach deep tissue and blood forming organs such as bone marrow). When applicable, dose attributable to neutrons is listed separately from the total deep dose equivalent.

11.1.3.9.6. **ALL SOURCE TEDE:** The total effective dose equivalent (in rem) to the individual from all sources for the monitoring period indicated. TEDE is defined as the sum of the deep dose equivalent [(for external exposures) and the committed effective dose equivalent (for internal exposures), expressed in units of either rem or Sv. The term TEDE does not apply to components of the individual's dose attributed to eye dose equivalent, extremity dose equivalent, or to shallow dose equivalent. **Note: Assigned external radiation doses and bioassay results less than the lower limit of detection are recorded as zero in the MRER.**

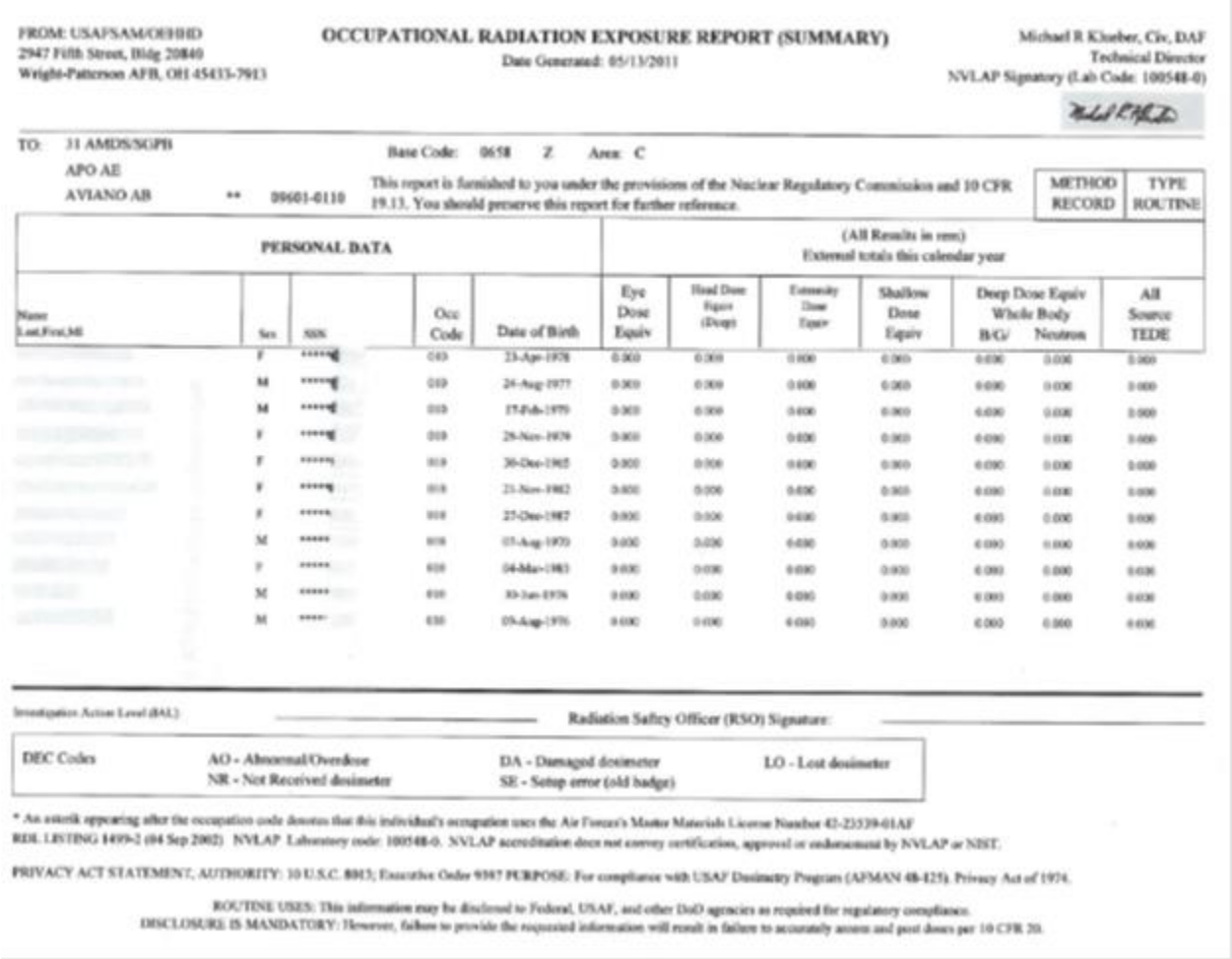
11.1.3.10. **DEC:** Digital Explanation Code – describes any unique circumstances related to the reported exposure. Commonly used codes include the following:

Table 11.1. Digital Explanation Codes.

DEC	Description
AO	Abnormal/overexposure reading
AD	IRSO assigned dose
LO	Dosimeter lost (old DEC category)
DM	Dosimeter damaged (old DEC category)
NR	Dosimeter not received
TS	Thyroid shield worn (unshielded dose equivalents shown)
ES	Eye shield worn (unshielded dose equivalents shown)
TE	Thyroid and eye shields worn (unshielded dose equivalents shown)

11.1.4. RDL LISTING 14992, Summary of Occupational Radiation Exposure. This listing is prepared for each dosimetry account by area and indicates the dose received by each individual monitored under the Dosimetry Program from the beginning of the calendar year to the date of the report. The date the form is prepared appears at the top of the form. **All results are printed in rem unless indicated otherwise.** A dash indicates the particular category is not applicable for the monitored individual.

Figure 11.3. RDL Listing 1499-2.



FROM: USAFSAM/OEHHD
2947 Fifth Street, Bldg 20840
Wright-Patterson AFB, OH 45433-7913

OCCUPATIONAL RADIATION EXPOSURE REPORT (SUMMARY)
Date Generated: 05/13/2011

Michael R Kloeber, Civ, DAF
Technical Director
NVLAP Signatory (Lab Code: 100548-0)

TO: 31 AMDS/SGPB
APO AE
AVIANO AB ** 09601-0110

Base Code: 0658 Z Area: C

This report is furnished to you under the provisions of the Nuclear Regulatory Commission and 10 CFR 19.13. You should preserve this report for further reference.

METHOD RECORD | TYPE ROUTINE

PERSONAL DATA					(All Results in rem) External totals this calendar year					
Name Last,First,MI	Sex	SSN	Occ Code	Date of Birth	Eye Dose Equiv	Head Dose Equiv (Deep)	Extremity Dose Equiv	Shallow Dose Equiv	Deep Dose Equiv Whole Body B/G/	Deep Dose Equiv Whole Body Neutron	All Source TEDE
	F	*****6	010	23-Apr-1978	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	M	*****6	010	24-Aug-1977	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	M	*****6	010	17-Feb-1979	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	F	*****6	010	29-Nov-1979	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	F	*****5	010	30-Dec-1985	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	F	*****9	010	23-Nov-1982	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	F	*****4	010	27-Dec-1987	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	M	*****	010	03-Aug-1970	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	F	*****	010	04-Mar-1983	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	M	*****	010	30-Jan-1976	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	M	*****	030	09-Aug-1976	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Investigation Action Level (IAL):

Radiation Safety Officer (RSO) Signature:

DEC Codes: AO - Abnormal/Overdose; DA - Damaged dosimeter; LO - Lost dosimeter; NR - Not Received dosimeter; SE - Setup error (old badge)

* An asterik appearing after the occupation code denotes that this individual's occupation uses the Air Force's Master Materials License Number 42-23539-01AF
RDL LISTING 1499-2 (04 Sep 2002) NVLAP Laboratory code: 100548-0. NVLAP accreditation does not convey certification, approval or endorsement by NVLAP or NIST.

PRIVACY ACT STATEMENT, AUTHORITY: 10 U.S.C. 8013; Executive Order 9397 PURPOSE: For compliance with USAF Dosimetry Program (AFMAN 48-125). Privacy Act of 1974.

ROUTINE USES: This information may be disclosed to Federal, USAF, and other DoD agencies as required for regulatory compliance.
DISCLOSURE IS MANDATORY: However, failure to provide the requested information will result in failure to accurately access and post doses per 10 CFR 20.

11.1.4.1. EXTERNAL TOTALS THIS YEAR.

11.1.4.2. **Eye Dose Equivalent:** Indicates the EDE for the lens of the eye of the calendar year to the date of the report.

11.1.4.3. Head **Dose Equivalent (Deep):** Indicates the EDE for the head of the calendar year to the date of the report.

11.1.4.4. **Extremity Dose Equivalent:** Indicates the EDE to the extremities of the calendar year to the date of the report. If the dose equivalent results are reported on RDL Listing 14991 by extremity dosimeter location and not the highest extremity value, the lifetime total is the sum of all the entries for the extremity location that received the highest dose during each monitoring period. No code is used to indicate dosimeter location.

11.1.4.5. **Shallow Dose Equivalent Skin:** Indicates the EDE for the skin of the calendar year to the date of the report.

11.1.4.6. **Deep Dose Equivalent Whole Body B/G/X-RAY:** Indicates the EDE for the whole body due to beta, gamma, and x-rays of the calendar year to the date of the report. This total value is included in Item 22.

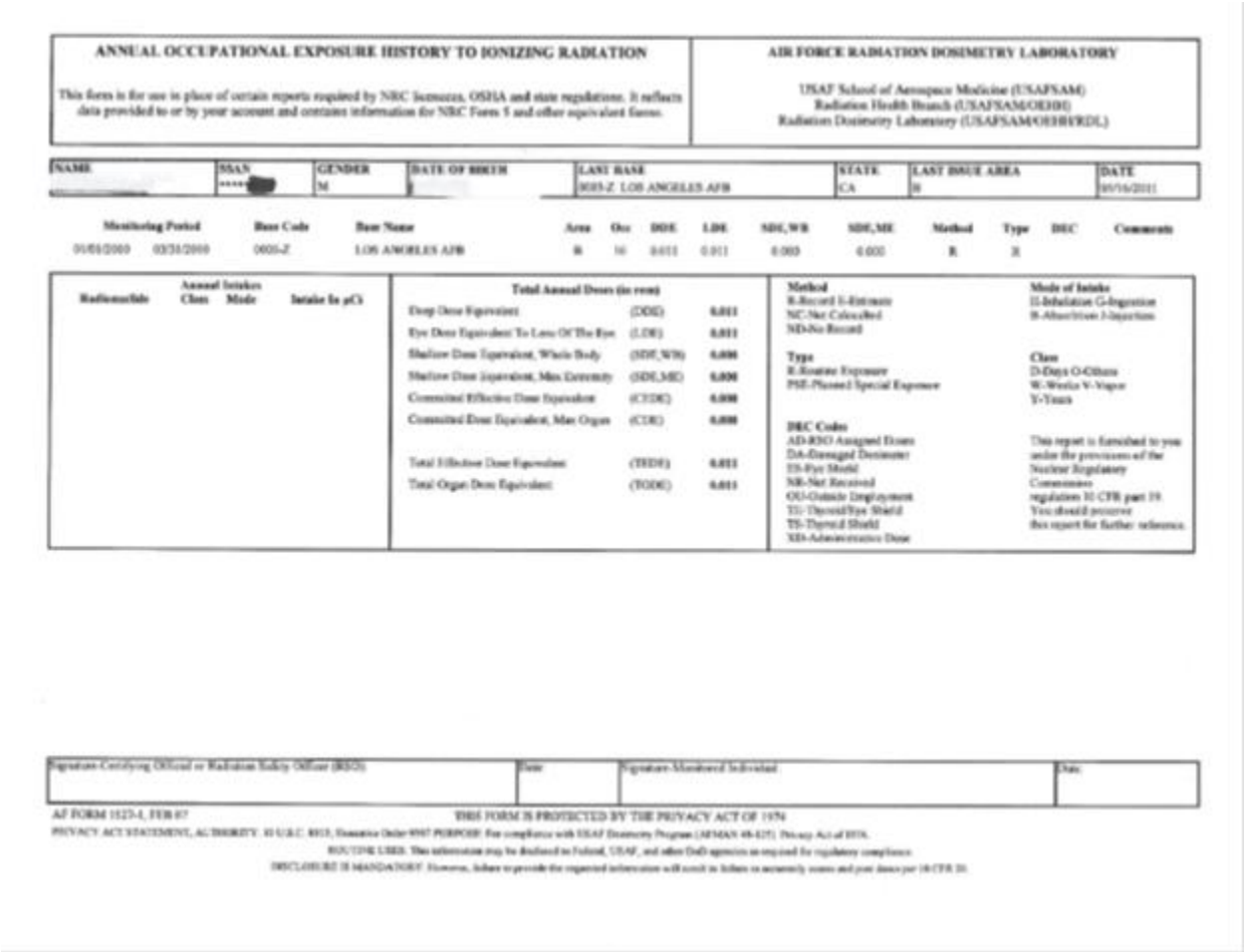
11.1.4.7. **Deep Dose Equivalent Whole Body Neutron:** Indicates the external dose equivalent for the whole body due to neutrons of the calendar year to the date of the report. This total value is included in Item 22.

11.1.4.8. ALL SOURCES TEDE.

11.1.4.9. **Total Effective Dose Equivalent:** Indicates the sum of the committed EDE (Item 18) and the total whole body DDE (Items 23a and 23b). **Note: Assigned external radiation doses and bioassay results less than the lower limit of detection are recorded as zero in the MRER.**

11.1.5. AF Form 1527-1, Annual Occupational Exposure History to Ionizing Radiation.

Figure 11.4. AF Form 1527-1.



ANNUAL OCCUPATIONAL EXPOSURE HISTORY TO IONIZING RADIATION

AIR FORCE RADIATION DOSIMETRY LABORATORY

This form is for use in place of certain reports required by NRC licensees, OSHA and state regulations. It reflects data provided to or by your account and contains information for NRC Form 5 and other equivalent forms.

USAF School of Aerospace Medicine (USAFSAM)
Radiation Health Branch (USAFSAM/OEHH)
Radiation Dosimetry Laboratory (USAFSAM/OEHHRDL)

NAME	SSAN	GENDER	DATE OF BIRTH	LAST BASE	STATE	LAST ISSUE AREA	DATE
	*****	M		0005-Z LOS ANGELES AFB	CA	R	05/16/2011

Monitoring Period		Base Code	Base Name	Area	Occ	DDE	LDE	SDE,WB	SDE,ME	Method	Type	DEC	Comments
01/01/2010	03/31/2010	0005-Z	LOS ANGELES AFB	R	10	0.011	0.011	0.000	0.000	R	R		

Radionuclide	Annual Intakes Class	Mode	Intake In μCi

Total Annual Doses (in rem)		
Deep Dose Equivalent	(DDE)	0.011
Eye Dose Equivalent To Lens Of The Eye	(LDE)	0.011
Shallow Dose Equivalent, Whole Body	(SDE,WB)	0.000
Shallow Dose Equivalent, Max Extremity	(SDE,ME)	0.000
Committed Effective Dose Equivalent	(CEDE)	0.000
Committed Dose Equivalent, Max Organ	(CDE)	0.000
Total Effective Dose Equivalent	(TEDE)	0.011
Total Organ Dose Equivalent	(TODE)	0.011

Method
R-Record I-Estimate
NC-Not Calculated
ND-No Record

Type
R-Routine Exposure
PSE-Planned Special Exposure

DEC Codes
AD-RSO Assigned Exam
DA-Damaged Dosimeter
ES-Eye Shield
NR-Not Received
OU-Outside Deployment
TE-Thyroid/Eye Shield
TS-Thyroid Shield
XB-Administrative Dose

Mode of Intake
I-Inhalation G-Ingestion
B-Absorption J-Injection

Class
D-Days O-Others
W-Weeks V-Vapor
Y-Years

This report is furnished to you under the provisions of the Nuclear Regulatory Commission regulation 10 CFR part 19. You should preserve this report for further reference.

Signature-Certifying Official or Radiation Safety Officer (RSO) | Date | Signature-Monitored Individual | Date

AF FORM 1527-1, FEB 07 THIS FORM IS PROTECTED BY THE PRIVACY ACT OF 1974

PRIVACY ACT STATEMENT, AUTHORITY: 10 U.S.C. 8013, Executive Order 9397 PURPOSE: For compliance with USAF Dosimetry Program (AFMAN 48-125). Privacy Act of 1974.

ROUTINE USES: This information may be disclosed to Federal, USAF, and other DoD agencies as required for regulatory compliance.

DISCLOSURE IS MANDATORY. However, failure to provide the requested information will result in failure to accurately assess and post doses per 10 CFR 20.

11.1.5.1. IDENTIFICATION DATA:

11.1.5.1.1. Name, SSN, Sex, and Date of Birth: Self-explanatory.

11.1.5.1.2. **Last Base:** The base code and plain-text identification of the last installation from which the individual received monitoring service during the year.

11.1.5.1.3. **State:** Self-explanatory.

11.1.5.1.4. **Last Issue Area:** The last monitoring area from which the individual received monitoring service during the year.

11.1.5.1.5. **Date:** The date the Form 1527-1 was generated.

11.1.5.2. EXTERNAL DOSIMETRY RESULTS:

11.1.5.2.1. **Monitoring Period:** Start and end dates.

11.1.5.2.2. **Base Code/Client Code:** Alpha-numeric code for the location at which the individual monitoring occurred.

11.1.5.2.3. **Base Name:** Plain-text identification of the installation.

11.1.5.2.4. **Area:** Working area (as defined by the IRSO) for which the individual monitoring was provided.

11.1.5.2.5. **OCC:** Occupation Code applicable to this monitoring period (see Attachment 4).

11.1.5.2.6. **DDE:** The absorbed dose (rem) to the whole body from radiation of sufficient energy to penetrate an absorber providing attenuation equivalent to 1,000 mg/cm^2 (i.e., sufficient to reach deep tissue and blood forming organs such as bone marrow). When applicable, dose attributable to neutrons is included the total DDE.

11.1.5.2.7. **LDE:** Absorbed dose (rem) from radiation of sufficient energy to penetrate an absorber providing attenuation equivalent to 300 mg/cm^2 (approximate density thickness of the cornea and aqueous humor).

11.1.5.2.8. **SDE, WB:** The absorbed dose (rem) to the skin of the whole body from radiation of sufficient energy to penetrate an absorber providing attenuation equivalent to 7 mg/cm^2 (approximately that afforded by the dead layer of the skin).

11.1.5.2.9. **SDE, ME:** The absorbed dose (rem) to the maximally exposed extremity (hands and forearms) from radiation of sufficient energy to penetrate an absorber providing attenuation equivalent to 7 mg/cm^2 (approximately that afforded by the dead layer of the skin).

11.1.5.3. **METHOD:** Basis for reported result – "R" (record), "E" (estimate), "ND" (no record).

11.1.5.4. **TYPE:** Circumstances of exposure (Routine or Planned Special Exposure).

11.1.5.5. **DEC:** Digital Explanation Code —describes any unique circumstances related to the reported exposure. Commonly used codes are listed in Table 11.1.

11.1.5.6. **COMMENTS:** Self-explanatory.

11.1.5.7. **INTERNAL DOSIMETRY:** For each identified radionuclide, the report identifies the intake class, mode of intake and calculated internal deposition (in µCi). Internal dose commitments to individual organs/organ types are identified as follows:

Table 11.2. Internal Organ Codes.

Code	Organ
GON	Gonads
BST	Breast
RBM	Red Bone Marrow
LNG	Lung
THY	Thyroid
BON	Bone Surface
RDM	Remainder

11.1.5.8. SUMMARY FOR YEAR [Total Annual Doses (in rem)]:

11.1.5.8.1. Deep Dose Equivalent (DDE).

11.1.5.8.2. Eye (Lens), Dose Equivalent (LDE).

11.1.5.8.3. Shallow Dose Equivalent, Whole Body (SDE, WB).

11.1.5.8.4. Shallow Dose Equivalent, Maximally Exposed Extremity (SDE, ME).

11.1.5.8.5. *Committed Effective Dose Equivalent (CEDE):* The whole body dose equivalent obtained by adding the products of the weighting factors applicable to each of the body organs or tissues that are irradiated and the committed dose equivalent ($H_{E,50}$) these organs or tissues have received. $H_{T,50}$ is the committed (organ) dose equivalent to an individual organ from a current uptake that will be delivered over the 50 years following the uptake. CEDE applies specifically to the dosimetry of internally deposited radionuclides. **Note: Assigned external radiation doses and bioassay results less than the lower limit of detection are recorded as zero in the MRER.**

11.1.5.8.6. *Committed Dose Equivalent (Max Organ) (CDE):* The maximum dose equivalent to an organ or tissue of reference (T) that will be received from an intake of radioactive material by an individual during the 50-year period following the intake.

11.1.5.8.7. *Total Effective Dose Equivalent (TEDE):* The sum of the deep dose equivalent (for external exposures) and the committed effective dose equivalent (for internal exposures), expressed in units of either rem or Sv. **Note: Assigned external radiation doses and bioassay results less than the lower limit of detection are recorded as zero in the MRER.**

11.1.5.8.8. *Total Organ Dose Equivalent (TODE):* The total organ dose equivalent for the maximally exposed organ. The TODE is the sum of the DDE and the CDE, expressed in units of rem or Sv.

11.1.5.9. **CERTIFICATION:** The bottom of each AF Form 1527-1 includes spaces for the dated signatures of the IRSO and the monitored individual.

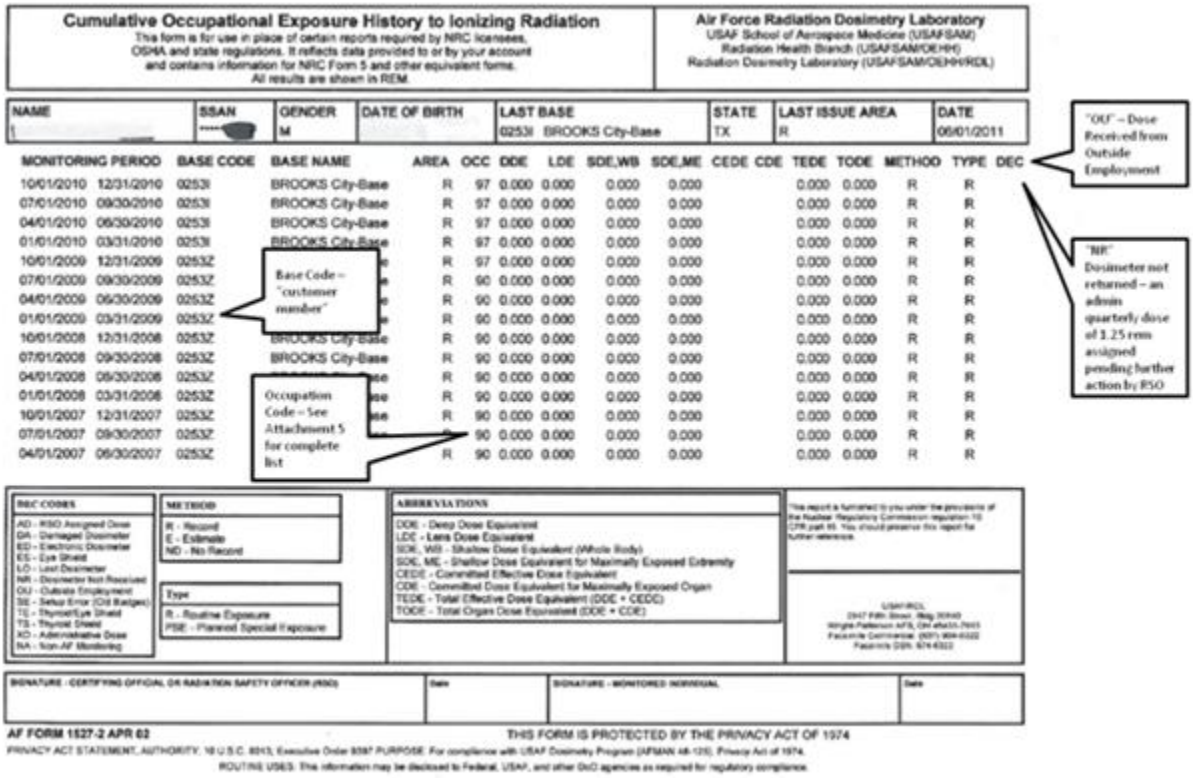
11.1.5.10. The monitored individual will be provided with a copy of the signed AF Form 1527-1, a copy will be placed in the individual's health record (if available) and a copy retained in the files of the IRSO.

11.1.5.11. The IRSO upon receiving the AF Form 1527-1 from USAFSAM/OEA/DOSIMETRY should compare the Form 1527-1 reported results against the RDL Listing 1499 (all versions) results and investigate any discrepancies. If no discrepancies are identified then the RDL Listing 1499 documents may be destroyed appropriately.

11.1.5.12. The IRSO makes reasonable (i.e., at least two) attempts to provide a copy of the AF Form 1527-1 to each monitored individual and establishes a system (e.g., logbook, annotation on retained copy) to document each individual's receipt of the form. As a minimum, documentation should include the date provided, individual's name and signature verifying receipt, and initials or signature of the IRSO or designee providing the form. The IRSO shall retain the AF Form 1527-1 for a period of five (5) years. (T-1) For individuals who have moved from the installation (e.g., permanent change of station, retirement, separation), one attempt will be made to send their AF Form 1527-1 to their last known forwarding address. (T-2) If the IRSO can confirm that the individual completed a permanent change of station and was monitored by the Dosimetry Program for the remainder of the year covered by the AF Form 1527-1 at the gaining installation then an attempt to provide a copy is not required. The monitored individual will receive the information on the AF Form 1527-1 that will be provided by the gaining IRSO. (T-2) **Note: This form contains individual identification information and must be protected against unauthorized disclosure as required by the Privacy Act of 1974.**

11.1.6. AF Form 1527-2, Cumulative Occupation Exposure History to Ionizing Radiation. (1) AF Form 1527-2, Cumulative Occupational Exposure History to Ionizing Radiation, is similar to AF Form 1527-1 except that it includes all information in the MRER related to the lifetime occupational radiation exposure history for an individual, including moonlighting and other sources of exposure external to AF practices. (2) Using the Radiation Dosimetry Web secure website, the IRSO can generate this form. Otherwise, this form is prepared by USAFSAM/OEA upon written request of the individual, the IRSO, or (with written concurrence of the individual) a third party such as a post-AF employer, the Department of Veterans Affairs, etc. (3)The contents of the form and explanation of fields are the same as shown above for AF Form 1527-1 except that, immediately following the last entry, a summary line is added showing the lifetime radiation exposure for the individual in terms of DDE, LDE, SDE-WB, SDE-ME, CEDE, CDE, TEDE, and TODE (as applicable).

Figure 11.5. AF Form 1527-2 (first page).



Cumulative Occupational Exposure History to Ionizing Radiation

This form is for use in place of certain reports required by NRC licensees, OSHA and state regulations. It reflects data provided to or by your account and contains information for NRC Form 5 and other equivalent forms. All results are shown in REM.

Air Force Radiation Dosimetry Laboratory
USAF School of Aerospace Medicine (USAFSAM)
Radiation Health Branch (USAFSAM/OEHH)
Radiation Dosimetry Laboratory (USAFSAM/OEHH/RDL)

NAME	SSAN	GENDER	DATE OF BIRTH	LAST BASE	STATE	LAST ISSUE AREA	DATE
[redacted]	[redacted]	M		0253I BROOKS City-Base	TX	R	06/01/2011

MONITORING PERIOD		BASE CODE	BASE NAME	AREA	OCC	DDE	LDE	SDE,WB	SDE,ME	CEDE	CDE	TEDE	TODE	METHOD	TYPE	DEC
10/01/2010	12/31/2010	0253I	BROOKS City-Base	R	97	0.000	0.000	0.000	0.000			0.000	0.000	R	R	
07/01/2010	09/30/2010	0253I	BROOKS City-Base	R	97	0.000	0.000	0.000	0.000			0.000	0.000	R	R	
04/01/2010	06/30/2010	0253I	BROOKS City-Base	R	97	0.000	0.000	0.000	0.000			0.000	0.000	R	R	
01/01/2010	03/31/2010	0253I	BROOKS City-Base	R	97	0.000	0.000	0.000	0.000			0.000	0.000	R	R	
10/01/2009	12/31/2009	0253Z	[illegible]	R	97	0.000	0.000	0.000	0.000			0.000	0.000	R	R	
07/01/2009	09/30/2009	0253Z	[illegible]	R	90	0.000	0.000	0.000	0.000			0.000	0.000	R	R	
04/01/2009	06/30/2009	0253Z	[illegible]	R	90	0.000	0.000	0.000	0.000			0.000	0.000	R	R	
01/01/2009	03/31/2009	0253Z	[illegible]	R	90	0.000	0.000	0.000	0.000			0.000	0.000	R	R	
10/01/2008	12/31/2008	0253Z	BROOKS City-Base	R	90	0.000	0.000	0.000	0.000			0.000	0.000	R	R	
07/01/2008	09/30/2008	0253Z	BROOKS City-Base	R	90	0.000	0.000	0.000	0.000			0.000	0.000	R	R	
04/01/2008	06/30/2008	0253Z	[illegible]	R	90	0.000	0.000	0.000	0.000			0.000	0.000	R	R	
01/01/2008	03/31/2008	0253Z	[illegible]	R	90	0.000	0.000	0.000	0.000			0.000	0.000	R	R	
10/01/2007	12/31/2007	0253Z	[illegible]	R	90	0.000	0.000	0.000	0.000			0.000	0.000	R	R	
07/01/2007	09/30/2007	0253Z	[illegible]	R	90	0.000	0.000	0.000	0.000			0.000	0.000	R	R	
04/01/2007	06/30/2007	0253Z	[illegible]	R	90	0.000	0.000	0.000	0.000			0.000	0.000	R	R	

"OU" – Dose Received from Outside Employment

"BF" Dosimeter not returned – an admin quarterly dose of 1.25 rem assigned pending further action by RSO

Base Code – "customer number"

Occupation Code – See Attachment 5 for complete list

DOC CODES
AD - RSO Assigned Dose
DR - Damaged Dosimeter
ED - Electronic Dosimeter
ES - Eye Shield
LO - Lost Dosimeter
NR - Dosimeter Not Received
OU - Outside Employment
SE - Setup Error (Crit Badges)
TE - Thyroid/Eye Shield
TS - Thyroid Shield
XO - Administrative Dose
NA - Non-AF Monitoring

METHOD
R - Record
E - Estimate
ND - No Record

Type
R - Routine Exposure
PSE - Planned Special Exposure

ABBREVIATIONS
DDE - Deep Dose Equivalent
LDE - Lens Dose Equivalent
SDE, WB - Shallow Dose Equivalent (Whole Body)
SDE, ME - Shallow Dose Equivalent for Maximally Exposed Extremity
CEDE - Committed Effective Dose Equivalent
CDE - Committed Dose Equivalent for Maximally Exposed Organ
TEDE - Total Effective Dose Equivalent (DDE + CEDE)
TODE - Total Organ Dose Equivalent (DDE + CDE)

"This report is furnished to you under the provisions of the Nuclear Regulatory Commission regulation 10 CFR part 20. You should preserve this report for further reference."

USAFSAM/RDL
2947 Fifth Street - Bldg 30040
Wright-Patterson AFB, OH 45433-7913
Facsimile Commercial: (937) 904-6322
Facsimile DSN: 674-6322

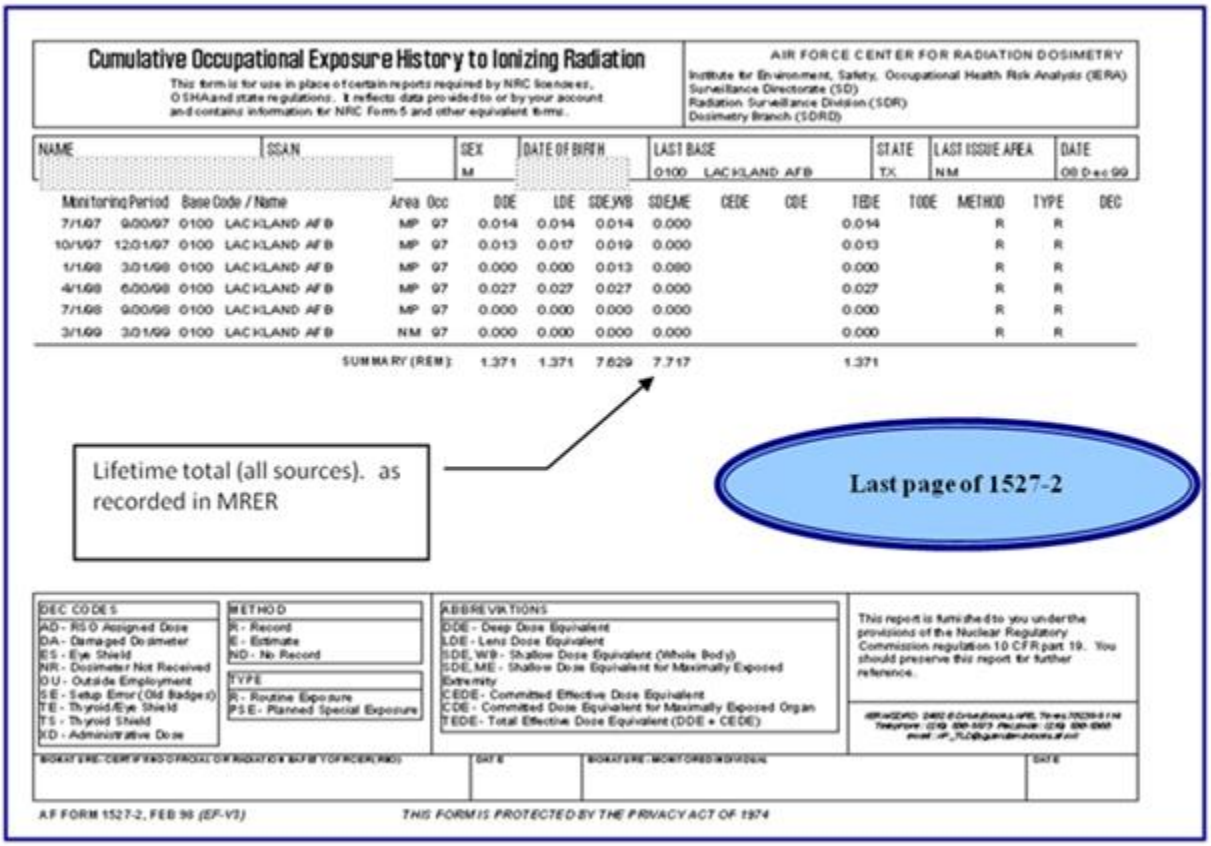
SIGNATURE - CERTIFYING OFFICIAL OR RADIATION SAFETY OFFICER (RSO) | Date | SIGNATURE - MONITORED INDIVIDUAL | Date

AF FORM 1527-2 APR 02

THIS FORM IS PROTECTED BY THE PRIVACY ACT OF 1974

PRIVACY ACT STATEMENT. AUTHORITY: 10 U.S.C. 8013, Executive Order 9397 PURPOSE: For compliance with USAF Dosimetry Program (AFMAN 48-125), Privacy Act of 1974.
ROUTINE USES: This information may be disclosed to Federal, USAF, and other DoD agencies as required for regulatory compliance.

Figure 11.6. AF Form 1527-2 (last page).



11.1.6.1. AF Form 2753, Radiological Sampling Data: The IRSO uses this form to submit bioassay samples to USAFSAM/OEA for analysis. The IRSO prepares AF Form 2753 before submitting samples to USAFSAM/OEA for analysis, forwards the original copy to USAFSAM/OEA with the bioassay sample, and maintains a copy until results (i.e., updated 1527-1) are received from USAFSAM/OEA.

11.1.6.2. NRC Form 4: The IRSO makes a reasonable effort to collect previous dosimetry histories for individuals having either past or present non-USAF employment. USAF personnel moonlighting in jobs where they are monitored for radiation exposure make arrangements to routinely (e.g., based on monitoring period, but no less than quarterly) provide these results to the IRSO. The IRSO ensures these results are forwarded to USAFSAM/OEA for incorporation into the MRER. The individual bears ultimate responsibility for ensuring any non-USAF dosimetry results become part of the MRER.

11.2. Statistical Summaries of Dosimetry Results.

11.2.1. Annual Personnel Radiation Exposure Summary.

11.2.1.1. Prior to 1 April of each calendar year, USAFSAM/OEA will submit a personnel radiation exposure summary report to AFMSA/SG3PB as required by AFPD 40-2, Attachment 1.

11.2.1.2. Any data that would make identification of specific individuals possible will be contained in an attachment to the report.

11.2.1.3. This report shall include the following as a minimum:

11.2.1.3.1. Zero average (all results), non-zero average (only non-zero results) and maximum annual TEDE dose for all occupational codes. Codes associated with NRC or radioactive material-related activities should be denoted for ease of reference. Results should be presented in a bar-chart format and compared to the previous year and the previous 5 years.

11.2.1.3.2. Zero average, non-zero average and maximum annual CEDE dose for all occupational codes. Results should be presented in a bar-chart format and compared to the previous year and the previous 5 years. Codes associated with NRC or radioactive material-related activities should be denoted for ease of reference.

11.2.2. Annual Exposure Summary Report by Occupation Code. Annually, USAFSAM/OEA will prepare a summary report of AF-wide radiation exposure data for the previous year showing the range and median recorded dose for each occupation code. This report will be distributed to all bases for use in evaluating exposures considered abnormal with respect to the applicable ALARA constraint.

Chapter 12

THE USAF MASTER RADIATION EXPOSURE REGISTRY (MRER).

12.1. General. In accordance with 10 CFR 19 and 20, the Air Force is required to maintain permanent dosimetry records for all persons entered into the Dosimetry Program. The MRER is a computer database registry maintained by USAFSAM/OEA. The MRER houses historical records of dose equivalent data for all persons presently or formerly registered in the program. Depending on the age of the data, some internal dosimetry results may not be in the MRER, but are instead maintained by USAFSAM/OEA. USAFSAM/OEA is the sole custodian of the MRER. The MRER also will provide an individual's historical dose due to military operations not considered in their occupational exposure history.

12.2. Responsibilities.

12.2.1. USAFSAM/OEA.

12.2.1.1. Permanently maintains records of all dosimetry, internal and external, for individuals entered into the Dosimetry Program.

12.2.1.2. The IRSO (Dosimetry Account Custodian). The IRSO reviews all records associated with the Dosimetry Program and reports any corrections to USAFSAM/OEA via the Radiation Dosimetry Web, annotation on the RDL Listing 1523 or via written correspondence. Correction of individual dose data in the MRER will only be made upon receipt of written request signed by the individual or after the IRSO submits the correct form using the secure website.

12.2.1.3. Individual. The individual is responsible for reviewing his/her dosimetry results and providing any corrections in writing to USAFSAM/OEA through the installation IRSO.

12.3. Forms and Reports Generated from Data in the MRER.

12.3.1. AF 1527-1, Annual Report of Individual Exposure to Ionizing Radiation.

12.3.2. AF 1527-2, Cumulative Report of Individual Exposure to Ionizing Radiation.

12.4. Requests for Radiation Exposure History (AF Form 1527-2).

12.4.1. Required Information. The IRSO can generate this report using the Radiation Dosimetry Web, or the IRSO, monitored individual, and other authorized organizations can request an AF Form 1527 in writing. These written requests must include:

12.4.1.1. The individual's name showing the last name, first name, and middle initial.

12.4.1.2. The SSN.

12.4.1.3. The individual's date of birth by day, month, year.

12.4.1.4. The approximate dates the individual was monitored by the Air Force. If the individual entered the service before 1 Jul 62, the location and dates of assignment and the previous Air Force Serial (Service) Number assigned must also be provided.

12.4.2. Authorization for Release. Because of Privacy Act requirements, a signed release statement must accompany requests for AF Form 1527 from the individual whose history is

requested. All requests from outside the Air Force for deceased individuals must be processed through the Department of Veterans Affairs or AFMSA/SG3PB.

CHARLES B. GREEN
Lieutenant General, USAF, MC, SFS
Surgeon General

Attachment 1

GLOSSARY OF REFERENCES AND SUPPORTING INFORMATION

References

STANAG 2473, *Commander's Guide to Radiation Exposures in Non-Article 5 Crisis Response Operations*, 6 October 2004

STANAG 2474, *Determination and Recording of Ionizing Radiation Exposure for Medical Purposes*, 21 May 2003.

Joint Publication 3-11, *Operations in Chemical, Biological, Radiological, and Nuclear (CBRN) Environments*, 26 August 2008.

DODI 6055.08, *Occupational Radiation Protection Program*, 15 Dec 2009

AFPD 40-2, Radioactive Materials (Non-Nuclear Weapons), 15 March 2007

AFPD 48-1, Aerospace Medicine Program, 3 October 2005

AFI 40-201, Managing Radioactive Materials in the USAF, 16 March 2011

AFI 48-148, Ionizing Radiation Protection, 12 October 2001

AFI 91-108, Air Force Nuclear Weapons Intrinsic Radiation and 91(B) Radioactive Material Safety Program, 21 Sep 2010

AFMAN 33-363, *Management of Records,* 1 March 2008

10 CFR, Chapter 1, Nuclear Regulatory Commission, Part 19—*Notices, Instructions and Reports to Workers: Inspection and Investigations*; Part 20—*Standards for Protection Against Radiation*

29 CFR, Chapter XVII—*Occupational Safety and Health Administration Department of Labor,* Part 1910 *Occupational Safety and Health Standards*

8.2 – *Guide for Administrative Practices in Radiation Monitoring* – 2 February 1973

8.4 – *Direct-Reading and Indirect-Reading Pocket Dosimeters* – 26 February 1973

8.7–*Instructions for Recording and Reporting Occupational Radiation Exposure Data*, November 2005

8.9–*Acceptable Concepts, Models, Equations, and Assumptions for a Bioassay Program*, July 1993

8.10 – *Operating Philosophy for Maintaining Occupational Radiation Exposures As Low As Is Reasonably Achievable*, May 1977

8.13 – *Instruction Concerning Prenatal Radiation Exposure*, June 1999

8.15 – *Acceptable Programs for Respiratory Protection*, October 1999

8.18 – *Information Relevant to Ensuring that Occupational Radiation Exposures at Medical Institutions Will Be As Low As Reasonably Achievable*, October 1982

8.20 – *Applications of Bioassay for I-125 and I-131*, September 1979

8.22 – *Bioassay at Uranium Mills*, August 1988

8.26 – *Applications of Bioassay for Fission and Activation Products*, September 1980

8.29 – *Instruction Concerning Risks from Occupational Radiation Exposure*, February 1996

8.32 – *Criteria for Establishing a Tritium Bioassay Program*, July 1988

8.34 – *Monitoring Criteria and Methods to Calculate Occupational Radiation Doses*, July 1992

8.35 – *Planned Special Exposures*, June 1992

8.36 – *Radiation Dose to the Embryo/Fetus*, July 1992

10.1 – *Compilation of Reporting Requirements for Persons Subject to NRC Regulations*, October 1981

EPA-520/1-88-ORD, Federal Guidance Report No. 11—*Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion*, September 1988

EPA-HQ-OAR-2005-0083 (52FR2822) *Radiation Protection Guidance to Federal Agency for Occupational Exposure*, 27 January 1987

HPS N13.6-1999, *Practice for Occupational Radiation Exposure Records Systems*, May 1999.

HPS N13.11-2009, *Personnel Dosimetry Performance—Criteria for Testing*, January 2009

HPS N13.30-1996, *Performance Criteria for Radiobioassay*, May 1996.

HPS N13.32-2008, *Performance Testing of Extremity Dosimeters*, November 2008

HPS N13.41-1997, *Criteria for Performing Multiple Dosimetry*, December 1996.

HPS N13.42-1997, *Internal Dosimetry for Mixed Fission Activation Products*, February 1997.

Safety Series No. 115 (Safety Standards), *International Basic Safety Standards for Protection Against Ionizing Radiation and for the Safety of Radiation Sources*, 5 March 2004

Safety Series No. 120 (Safety Fundamentals), *Radiation Protection and the Safety of Radiation Sources*, 23 February 1996

Safety Standards Series No. RS-G-1.1 (Safety Guide), *Occupational Radiation Protection*, 13 October 1999

Safety Standards Series No. RS-G-1.2 (Safety Guide), *Assessment of Occupational Exposure Due to Intakes of Radionuclides*, 2 November 1999

Safety Standards Series No. RS-G-1.3 (Safety Guide), *Assessment of Occupational Exposure Due to External Sources of Radiation*, 28 September 1999

33 –*Protection Against Ionizing Radiation from External Sources Used in Medicine*, Annals of the ICRP, 9 (1), 1982

34 –*Protection of the Patient in Diagnostic Radiology*, Annals of the ICRP, 9 (2-3) 1982

35 –*General Principles of Monitoring for Radiation Protection of Workers*, Annals of the ICRP, 9 (4), 1982

36 –*Protection Against Ionizing Radiation in the Teaching of Science*, Annals of the ICRP, 10 (1), 1983

41 –*Non-stochastic Effects of Ionizing Radiation*, Annals of the ICRP, 14 (3), 1984

44 –*Protection of the Patient in Radiation Therapy*, Annals of the ICRP 15 (2), 1985

51 –*Data for Use in Protection Against External Radiation*, Annals of the ICRP 17 (2-3), 1987

52 –*Protection of the Patient in Nuclear Medicine*, Annals of the ICRP, 17 (4), 1987

53 –*Biokinetics and Dosimetry: General Considerations (*including addenda of 2000, 2002 and 2004), Annals of the ICRP, 18 (1-4), 1987

54 –*Individual Monitoring for Intakes of Radionuclides by Workers: Design and Interpretation*, Annals of the ICRP, 19 (1-3), 1988.

57 –*Radiological Protection of the Worker in Medicine and Dentistry*, Annals of the ICRP, 20 (3) 1989

62 –*Radiological Protection in Biomedical Research*, Annals of the ICRP, 22 (3), 1991

64 –*Protection from Potential Exposure,* Annals of the ICRP, 23 (1), 1993

54 –*Medical Radiation Exposure of Pregnant and Potentially Pregnant Women* (1977)

65 –*Management of Persons Accidentally Contaminated with Radionuclides* (1980)

68 –*Radiation Protection in Pediatric Radiology* (1981)

69 –*Dosimetry of X-Ray and Gamma-Ray Beams for Radiation Therapy in the Energy Range 10 keV to 50 MeV* (1981)

73 – *Protection in Nuclear Medicine and Ultrasound Diagnostic Procedures in Children* (1983).

82 –*SI Units in Radiation Protection and Measurements* (1985)

84 –*General Concepts for the Dosimetry of Internally Deposited Radionuclides* (1985)

87 –*Use of Bioassay Procedures for Assessment of Internal Radionuclide Deposition* (1987)

93 –*Ionizing Radiation Exposure of the Population of the United States* (1987)

94 –*Exposure of the Population in the United States and Canada from Natural Background Radiation* (Supersedes NCRP Report No. 45) (1988)

95 –*Radiation Exposure of the U.S. Population from Consumer Products and Miscellaneous Sources* (Supersedes NCRP Report No. 56) (1988)

98 – *Guidance on Radiation Received in Space Activities* (1989)

100 –*Exposure of the U.S. Population from Diagnostic Medical Radiation* (1988)

101 –*Exposure of the U.S. Population from Occupational Radiation* (1989)

102 –*Medical X-Ray Electron Beam and Gamma-Ray Protection for Energies Up to 50 MeV (Equipment Design, Performance and Use)* (Supersedes NCRP Report No. 33) (1989)

105 –*Radiation Protection for Medical and Allied Health Personnel* (Supersedes NCRP Report No. 48) (1989)

107 –*Implementation of the Principle of As Low As Reasonably Achievable (ALARA) for Medical and Dental Personnel* (1990)

114 –*Maintaining Radiation Protection Records* (1992)

115 –*Risk Estimates for Radiation Protection* (1993)

116 –*Limitation of Exposure to Ionizing Radiation* (Supersedes NCRP Report No. 91) (1993)

121 –*Principles and Application of Collective Dose in Radiation Protection* (1995)

122 –*Use of Personnel Monitors to Estimate Effective Dose Equivalent and Effective Dose to Workers for External Exposure to Low-LET Radiation* (1995)

124 –*Sources and Magnitude of Occupational and Public Exposures from Nuclear Medicine Procedures* (1996)

127 – *Operational Radiation Safety Program* (1998)

133 – *Radiation Protection for Procedures Performed Outside the Radiology Department* (2000)

134 – *Operational Radiation Safety Training* (2000)

145 –*Radiation Protection in Dentistry* (2003)

148 – *Radiation Protection in Veterinary Medicine* (2004)

155 – *Management of Radionuclide Therapy* (2006)

157 – *Radiation Protection in Educational Institutions* (2007)

Handbook No. 150, *National Voluntary Laboratory Accreditation Program – Procedures and General Requirements*, February 2006

Handbook No 150-4, *National Voluntary Laboratory Accreditation Program – Ionizing Radiation Dosimetry*, August 2005

Special Publication 812, *Criteria for the Operation of Federally-Owned Secondary Calibration Laboratories (Ionizing Radiation)*, October 1991.

Technical Note 1297, *Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results*, September 1994.

Abbreviations and Acronyms

711th HPW/CC—711th Human Performance Wing

AF—Air Force

AFI—Air Force Instruction

AFM—Air Force Manual

AFMAN—Air Force Manual

AFMC—Air Force Materiel Command

AFMSA/SG3PB—Air Force Medical Support Agency/Radiation Protection Division

AFPD—Air Force Policy Directive

AFSC—Air Force Specialty Code

ALARA—As Low As Reasonably Achievable

ALI—Annual limits of intake

ANSI—American National Standards Institute

BE—Bioenvironmental Engineering

BE—Bioenvironmental Engineer

Bq—Becquerel

CC—Commander

CDE—Committed dose equivalent

CEDE—Committed effective dose equivalent

CFR—Code of Federal Regulations

Ci—Curie

cm—centimeter (length)

cm2—square centimeter (area)

CONUS—Continental United States

DAC—Derived Air Concentration

DASAF/ESOH—Deputy Assistant Secretary of the Air Force/Energy, Environment, Safety and Occupational Health

DDE—Deep dose equivalent

DEC—Digital Explanation Code

DoD—Department of Defense

DODI—Department of Defense Instruction

DOE—Department of Energy

DOELAP—DOE Laboratory Accreditation Program

DTRA—Defense Threat Reduction Agency

EDAPTS—

EOD—Explosive Ordnance Disposal

ECC—Energy Compensation Coefficient

EDE—Effective dose equivalent

EPA—US Environmental Protection Agency

EPD—Electronic Personnel Dosimeter

Gy—Gray

HIPAA—Health Insurance Portability and Accountability Act

HPW—–Human Performance Wing

HQ—–Headquarters

HQ AFMC/CC—Commander, Headquarters Air Force Materiel Command

HQ AFMC/SG—Command Surgeon, Air Force Materiel Command

HQ USAF/SG—Headquarters, United States Air Force Surgeon General

IAW—In Accordance With

ICRP—International Commission on Radiological Protection

INRAD—Intrinsic Radiation

IRSO—Installation Radiation Safety Officer

LDE—Lens Dose Equivalent

LLD—Lower Limit of Detection

MAJCOM—Major Command

mg—milligram

mrem—milliRoentgen Equivalent Man

MRER—Master Radiation Exposure Registry

mSv—milliSievert

MTF—Medical Treatment Facility

NCRP—National Council on Radiation Protection and Measurements

NIST—National Institute of Standards and Technology

NRC—US Nuclear Regulatory Commission or its duly authorized representatives.

NVLAP—National Voluntary Laboratory Accreditation Program

OCC—Occupation Code

OCONUS—Outside the Continental United States

OH-MIS—Occupational Health Management Information System

OI—Operating Instruction

OSI—Office of Special Investigation

PCS—Permanent Change of Station

PDF—Portable Digital Format

PDO—Publication Distribution Office

PH—Public Health

PNNL—Pacific Northwest National Laboratory

rad—radiation absorbed dose

RCF—Radiation Calibration Facility

Rem—Roentgen Equivalent Man

RIC——Radioisotope Committee

SDE——Shallow Dose Equivalent

SG——Surgeon General

SSN——Social Security Number

STANAG—Standardization Agreement

TDY——Temporary Duty

TEDE——Total Effective Dose Equivalent

TLD——Thermoluminescent Dosimeter

US——United States

USAF——United States Air Force

USAFSAM——United States Air Force School of Aerospace Medicine

USAFSAM/CC—Commander, U S Air Force School of Aerospace Medicine

USAFSAM/OEA—United States Air Force School of Aerospace Medicine/ Analytical Services Division

U.S.C.—United States Code

WMD——Weapons of Mass Destruction

Terms

Absorbed dose—The energy imparted by ionizing radiation per unit mass of irradiated material. The units of absorbed dose are the rad and the Gray (Gy); (1 rad = 0.01 Gy).

Act—The Atomic Energy Act of 1954 (42 U.S.C. 2011 et seq.), as amended.

Activity—The rate of disintegration (transformation) or decay of radioactive material. The units of activity are the curie (Ci) and the Becquerel (Bq).

Administrative dose (administratively assigned dose)—A value assigned in a dose report in cases where a dosimeter is not returned for processing at the end of the wear period, is damaged, or cannot be evaluated due to other factors. Administratively assigned doses must be investigated by the IRSO as "Abnormal Exposures" following the procedure detailed in Chapter 8 of this manual.

Adult—An individual 18 or more years of age.

Airborne radioactive material—Radioactive material dispersed in the air in the form of dusts, fumes, particulates, mists, vapors, or gases.

Airborne radioactivity area—A room, enclosure, or area in which airborne radioactive materials, composed wholly or partly of licensed material, exist in concentrations (1) in excess of the Derived Air Concentrations (DAC), specified in appendix B, to Secs. 20.1001-20.2401, or (2) to such a degree that an individual present in the area without respiratory protective equipment could exceed, during the hours an individual is present in a week, an intake of 0.6 percent of the ALI or 12 DAC-hours.

ALARA—Acronym for "as low as is reasonably achievable" means making every reasonable effort to maintain exposures to radiation as far below established dose limits as is practical and consistent with the purpose for which the licensed activity is undertaken, taking into account the state of technology, the economics of improvements in relation to state of technology, the economics of improvements in relation to benefits to the public health and safety, and other societal and socioeconomic considerations, and in relation to utilization of nuclear energy and licensed materials in the public interest.

Albedo—Specific to dosimetry it refers to detecting neutron radiation that is scattered by the wearer's body.

Annual limit on intake (ALI)—The derived limit for the amount of radioactive material taken into the body of an adult worker by inhalation or ingestion in a year. ALI is the smallest value of intake of a given radionuclide in a year by the reference man that would result in a committed effective dose equivalent of 50 mSv (5 rem) or a committed dose equivalent (H_T) of 500 mSv (50 rem) to any individual organ or tissue. (ALI values for intake by ingestion and by inhalation of selected radionuclides are given in Table 1, Columns 1 and 2, of appendix B to Secs. 20.1001-20.2401, 10 CFR 20.)

Background radiation—Radiation from cosmic sources, naturally occurring radioactive materials, includes radon (except as a decay product of source or special nuclear material) and global fallout as it exists in the environment from the testing of nuclear explosive devices. The term "background radiation" does not include radiation from source, byproduct, or special nuclear materials regulated by the NRC.

Becquerel (Bq)—The SI unit of radioactivity equivalent to one nuclear transformation per second. One curie is 3.7×10^{10} (37 billion) Bq.

Bioassay (radiobioassay)—The determination of kinds, quantities or concentrations, and in some cases, the locations of radioactive material in the human body, whether by direct measurement (in vivo bioassay) or by indirect analysis and evaluation of materials excreted or removed from the human body (in vitro bioassay).

Byproduct material—Any radioactive material (except source or SNM) yielded in, or made radioactive by, exposure to the radiation incident to the process of producing or using source or SNM. The definition of byproduct material has changed with the Energy Policy Act of 2005 to include some forms of naturally occurring or accelerator produced radioactive material (reference AFPD 40-2).

Calendar quarter—A period of time of not less than 12 consecutive weeks or more than 14 consecutive weeks. The first calendar quarter shall begin in January or begin with the dosimetry issue cycle closest to January. Subsequent calendar quarters shall begin within 12 or 14 weeks of that date so that no day is included in both quarters or omitted from a quarter.

Class (or lung class or inhalation class)—A classification scheme for inhaled material according to its rate of clearance from the pulmonary region of the lung. Materials are classified as D, W, or Y, which applies to a range of clearance half-times: for Class D (days), less than 10 days; for Class W (weeks), from 10 to 100 days; and for Class Y (years), greater than 100 days.

Collective dose—The sum of the individual doses received in a given period of time by a specified population from exposure to a specified source of radiation.

Commission—See Nuclear Regulatory Commission.

Committed dose equivalent (CDE) **(HT,50)**—The dose equivalent to organs or tissues of reference (T) that will be received from an intake of radioactive material by an individual during the 50-year period following the intake.

Committed effective dose equivalent (CEDE) **(HE,50)**—The whole body dose equivalent obtained by adding the products of the weighting factors applicable to each of the body organs or tissues that are irradiated and the committed dose equivalent ($H_{E,50}$) these organs or tissues, where $H_{T,50}$ is the committed (organ) dose equivalent to an individual organ from a current uptake, that will be delivered over the 50 years following the uptake. CEDE applies specifically to the dosimetry of internally deposited radionuclides.

$CEDE = H_{E,50} = \Sigma W_T H_{T,50}$

Constraint (dose constraint)—A value above which specified actions are required.

Constraint (dose constraint)—A value above which specified actions are required.

Control dosimeter—A dosimeter that measures the background radiation accumulated during the transit and storage of personnel dosimeters.

Controlled area—An area outside of a restricted area but inside the site boundary, access to which can be limited by the licensee for any reason.

Critical organ—That organ which will sustain the greatest absorbed dose and whose associated damage by a radionuclide entering the human body will result in greatest potential impairment to the body due to the organ's radiosensitivity.

Deep dose equivalent (DDE) **(H_D)**—The dose assigned to personnel from external whole-body exposure, it is the dose equivalent at a tissue depth of one cm (1000 mg/cm^2) which is expressed in units of rem or Sievert (Sv).

Derived Air Concentration (DAC)—The concentration of a given radionuclide in air which, if breathed by the reference man for a working year of 2,000 hours under conditions of light work (inhalation rate 1.2 cubic meters of air per hour), results in an intake of one ALI. DAC values are given in Table 1, Column 3, of Appendix B to Secs. 20.1001-20.2401 of 10 CFR 20.

Derived Air Concentration-hour (DAC-hour)—The product of the concentration of radioactive material in air (expressed as a fraction or multiple of the derived air concentration for each radionuclide) and the time of exposure to that radionuclide, in hours. A licensee may take 2,000 DAC-hours to represent one ALI, equivalent to a committed effective dose equivalent of 5 rem (0.05 Sv) dose (radiation dose).

Digital Explanation Code (DEC)—An informational code assigned by USAFSAM/OEA to indicate special circumstances concerning the dose equivalent that is being reported. Valid codes are listed in paragraph 11.1.3.10 of this manual.

Dose (radiation dose)—A generic term that includes absorbed dose, dose equivalent (H_T), effective dose equivalent (H_E), committed dose equivalent (CDE), committed effective dose equivalent (CEDE), or total effective dose equivalent (TEDE).

Dose equivalent (HT)—The product of the absorbed dose in tissue (***DT***) and the quality factor (***Q***), and all other necessary modifying factors at the location of interest where ***HT*** = ***DT Q***. The

units of dose equivalent are the rem and Sievert (Sv). (0.01 Sv = 1 rem). The dose equivalent in Sv is equal to the absorbed dose in Gray multiplied by the ***Q***; 1 Sv = 100 rem. Its purpose is to have a single unit, regardless of the type of radiation, describing the radiation effect on man. See also Deep Dose Equivalent, Eye-Dose Equivalent, and Shallow-Dose Equivalent.

Dosimeter—A device that detects and measures accumulated ionizing radiation dose received by occupationally exposed individuals. The Dosimetry Program uses thermoluminescent dosimeters (TLDs). Examples of other types of dosimeters include film badges, pocket ionization chambers, Electronic Personnel Dosimeters (EPD) and CR-39 fast neutron detectors.

Dosimetry processor—An individual or organization that processes and evaluates individual monitoring equipment in order to determine the radiation dose delivered to the individual.

Effective Dose Equivalent (EDE), (HE)—The sum of the products of the dose equivalent to the organ or tissue (H_T) and the weighting factors (w_T) applicable to each of the body organs or tissues that are irradiated ($H_E = W_T H_T$).

Embryo/fetus—The developing human organism from conception until the time of birth.

Entrance or access point—Any location through which an individual could gain access to radiation areas or to radioactive materials. This includes entry or exit portals of sufficient size to permit human entry, irrespective of their intended use.

Exposure—Being exposed to ionizing radiation or to radioactive material.

External dose—The portion of the dose equivalent received from radiation sources outside the body.

External emitter—A radionuclide or ionizing radiation producing device located external to the body.

Extremity—The hand, elbow, arm below the elbow, foot, knee, or leg below the knee.

Extremity Dose Equivalent—The external dose equivalent to the extremities assessed at a tissue depth of 7 millimeters (7 mg/cm^2). This limit, set by 10 CFR 20 as the allowable dose to the skin of the whole body or the skin of the extremities, is 50 rem (0.5 Sv) in a year.

Extremity Dosimeter—A monitoring device used to determine the dose equivalent delivered to the extremities of the body (knees and the rest of the legs below the knees and the elbows and the rest of the arms below the elbows). USAFSAM/OEA currently uses only the ring dosimeter (sometimes called a "finger ring") for extremity monitoring.

Eye dose equivalent—The external dose equivalent assessed at a tissue depth of 0.3 centimeters (300 mg/cm^2). This total value must not exceed 37.5 mSv (3.75 rem) per quarter or 150 mSv (15 rem) in one year.

Generally applicable environmental radiation standards—Standards issued by the EPA under the authority of the Atomic Energy Act of 1954, as amended, that impose limits on radiation exposures or levels, or concentrations or quantities of radioactive material, in the general environment outside the boundaries of locations under the control of persons possessing or using radioactive material.

Government agency—Any executive department, commission, independent establishment, corporation wholly or partly owned by the United States of America which is an instrumentality

of the United States, or any board, bureau, division, service, office, officer, authority, administration, or other establishment in the executive branch of the government.

Gray (Gy)—Unit of absorbed dose that is equivalent to 100 rad.

Head dose equivalent—The external dose equivalent to the head assessed at a tissue depth of 10 millimeters (1000 mg/cm^2). This total value must not exceed 12.5 mSv (1.25 rem) per quarter. 10 CFR 20 limits this to 50 mSv (5 rem) in one year and with a maximum of 30 mSv (3 rem) in any quarter.

High radiation area—An area accessible to individuals in which radiation levels from radiation sources external to the body could result in an individual receiving a dose equivalent in excess of 1 mSv (0.1 rem) in 1 hour at 30 centimeters from the radiation source or from any surface that the radiation penetrates.

Individual—Any human being.

Individual monitoring—(1) The assessment of dose equivalent by using devices designed to be worn by an individual; (2) The assessment of committed effective dose equivalent by bioassay (see Bioassay) or by determination of the time-weighted air concentrations to which an individual has been exposed, i.e., DAC-hours; or (3) The assessment of dose equivalent by the use of survey data.

Individual monitoring devices (individual monitoring equipment)—Devices designed to be worn by a single individual for the assessment of dose equivalent such as film badges, thermoluminescent dosimeters (TLDs), pocket ionization chambers, and personal ("lapel") air sampling devices.

Installation Radiation Safety Officer (IRSO)—An individual, normally a Health Physicist, Bioenvironmental Engineer, Department of the Air Force civilian, or a qualified BE Craftsman designated in writing by the installation commander to manage the radiation safety program for the installation or using activity. This person may or may not be the IRSO responsible for activities conducted under a given USAF Radioactive Materials Permit.

Intake—The amount of radioactive material taken into the body by inhalation, absorption through the skin, injection, ingestion, or through wounds.

Internal dose—That portion of the dose equivalent received from radioactive material taken into the body.

Internal emitter—A radionuclide that is deposited in the body.

Intrinsic radiation—Ionizing radiation emitted through the weapon surface or directly from exposed components of nuclear weapons.

Investigation Action Level—(1) A dose equivalent value or radionuclide intake activity set by the IRSO that requires further investigation when exceeded. Levels are normally tailored to each using section's historical dosimetry data in order to promptly identify and correct adverse trends; (2) The CEDE from radioactive material taken into the human body or dose equivalent from an external radiation source to which the worker is occupationally exposed which justifies further investigation. Such an investigation generally includes a review of the circumstances associated with the apparently abnormal internal or external personnel dose equivalent, assessment of the

consequences and mitigation or prevention of such a personnel dose equivalent of similar magnitude in the future. (Definition taken from NRC guidance.)

Ionizing radiation—Any electromagnetic or particulate radiation capable of producing ions, directly or indirectly in its passage through matter. Ionizing radiation includes gamma rays, x-rays, alpha particles, beta particles, neutrons, protons and other particles and electromagnetic waves capable of producing ions.

Lens dose equivalent **(H_E) (LDE)**—The dose equivalent to the lens of the eye from external exposure of the lens of the eye to some ionizing radiation source. It is measured at an eye lens tissue depth of 0.3 cm (300 mg/cm^2).

License—A license issued under the regulations in Parts 30 through 36, 39, 40, 50, 60, 61, 70, or 72 of Title 10, Code of Federal Regulations.

Licensed material—Source material, special nuclear material, or byproduct material received, possessed, used, transferred or disposed of under a general or specific license issued by the Nuclear Regulatory Commission.

Licensee—The holder of a license.

Limits (dose limits)—The permissible upper bounds of radiation doses.

Lost or missing licensed material—Licensed material whose location is unknown. It includes material that has been shipped but has not reached its destination and whose location cannot be readily traced in the transportation system.

Master Radiation Exposure Registry (MRER)—The USAF's sole permanent record keeping registry of occupational ionizing radiation exposures for all personnel (past and present) enrolled in the Dosimetry Program. USAFSAM/OEA maintains the MRER.

Member of the public—Any individual except when that individual is receiving an occupational dose.

Minor——An individual less than 18 years of age.

Monitoring (radiation monitoring, radiation protection monitoring)—The measurement of radiation levels, concentrations, surface area concentrations or quantities of radioactive material and the use of the results of these measurements to evaluate potential exposures and doses.

National Voluntary Laboratory Accreditation Program (NVLAP)—A program administered by the National Institute of Standards and Technology (NIST) for the accreditation of ionizing radiation dosimetry processing laboratories. Accreditation is based on three rounds of open blind performance testing and site visits conducted by NVLAP National Technical Experts and is repeated every two years. Separate standards applicable to whole body and extremity dosimetry are detailed in NIST Handbook 150, NIST Handbook 150-4 and standards published by the Health Physics Society.

Neutron Dosimeter—A monitoring device that has special filtration to enable it to distinguish between fast and thermal neutrons.

Nonstochastic effects—Health effects, the severity of which varies with the dose and for which a threshold is believed to exist. Radiation-induced cataract formation is an example of a nonstochastic effect (also called a deterministic effect).

Occasionally-exposed individual—An individual whose work is not normally performed in a restricted area and whose duties do not normally involve exposure to ionizing radiation or radioactive material. Such individuals may, however, have reason to enter a restricted area in the performance of their duties. Examples are messengers, deliverymen, and maintenance workers.

Occupational dose—The dose received by an individual in the course of employment in which the individual's assigned duties involve exposure to radiation and/or radioactive material from licensed and unlicensed sources of radiation, whether in the possession of the licensee or other person. Occupational dose does not include doses received from background radiation, from any medical administration the individual has received, from exposure to patients administered RAM and released IAW applicable regulations, from voluntary participation in medical research programs, or as a member of the public.

Occupational Exposure—Routine exposure of Department of Defense (DOD) personnel to radiation associated with DOD operations during performance of their official duties. Occupational exposure does not include exposures from natural background radiation or those as a patient of practitioners of the healing arts.

Overexposure (quarterly or annual)—Any accumulated or one-time ionizing radiation exposure exceeding the limits specified in 10 CFR 20.

Permit—A written authorization to possess and use radiation sources issued by AFMSA/SG3PB under the provisions of the NRC Air Force Master Material License.

Permittee—The holder of a permit issued by the Air Force Radioisotope Committee authorizing possession and/or use of radioactive material. The permittee is typically a squadron commander, or higher or civilian equivalent

Person—Any individual, corporation, partnership, firm, association, trust, estate, public or private institution, group, Government agency other than the NRC or the DOE subject to the licensing and related regulatory authority of the NRC and/or the USAF Master Material License.

Public dose—The dose received by a member of the public from exposure to radiation and/or radioactive material released by a licensee, or to any other source of radiation under the control of the licensee. Public dose does not include occupational dose or doses received from background radiation, from any medical administration the individual has received, or from voluntary participation in medical research programs.

Quality Factor (Q)—The modifying factor (shown in Table A4.1) that is used to derive dose equivalent (biological effectiveness for increased fatal cancer risk) from absorbed dose.

Table A1.1 Radiation Quality Factors.—

Quality Factor (Neutron) (Neutron Quality Factor)—If it is more convenient to measure the neutron flux rate than to determine the neutron dose equivalent rate in rem per hour or Sievert per hour, as provided in 10 CFR 20, 1 rem (0.01 Sv) of neutron radiation of unknown energies may, for purposes of the regulations in 10 CFR 20, be assumed to result from a total flux of 25 million neutrons per square centimeter incident upon the body. If sufficient information exists to estimate the approximate energy distribution of the neutrons, the licensee may use the flux rate per unit dose equivalent or the appropriate Q value from Table A4.2 to convert a measured tissue dose in rads to dose equivalent in rem.

Table A1.2 Neutron Quality Factors.—

Quarter—A period of time equal to one-fourth of the year observed by the licensee (approximately 13 consecutive weeks), providing that the beginning of the first quarter in a year coincides with the starting date of the year and that no day is omitted or duplicated in consecutive quarters.

Radiation Absorbed Dose or Rad—A conventional unit of absorbed dose. One rad is equal to an absorbed dose of 100 ergs/gram or 0.01 joule/kilogram (0.01 Gray).

Radiation (ionizing radiation)—Alpha particles, beta particles, gamma rays, x-rays, neutrons, high-speed electrons, high-speed protons, and other particles capable of producing ions. Radiation, as used in 10 CFR 20, does not include non-ionizing radiation, such as radio- or microwaves, or visible, infrared, or ultraviolet light.

Radiation area—An area accessible to individuals in which radiation levels could result in an individual receiving a dose equivalent in excess of 0.005 rem (0.05 mSv) in 1 hour at 30 cm from the radiation source or from any surface that the radiation penetrates.

Radiation monitoring—Evaluating or measuring radiation levels and amounts or concentrations of radionuclides in air, water, or other materials to evaluate potential exposures and doses to personnel.

Radiation sources—RAM, equipment, or devices which spontaneously generate or are capable of generating ionizing radiation. Examples include nuclear reactors, medical and dental radiographic and fluoroscopic x-ray systems, particle generators and accelerators, certain electromagnetic generators operating at electrical potentials that result in the production of x-rays, x-ray diffraction, industrial radiographic and spectrographic equipment, electron microscopes, electron-beam welding, melting, and cutting equipment, nuclear moisture or density gauges, byproduct, source, and special nuclear materials, natural or accelerator-produced radioactive materials, materials containing induced or deposited radioactivity and radioactive commodities.

Radionuclide—An unstable isotope of an element that decays or disintegrates spontaneously, thereby emitting radiation. It is characterized by its atomic number (Z), mass number (A) and nuclear energy state.

Reference Man—A hypothetical aggregation of human physical and physiological characteristics arrived at by international consensus. These characteristics may be used by researchers and public health workers to standardize results of experiments and to relate biological insult to a common base.

Roentgen Equivalent Man or rem—The conventional unit of any of the quantities expressed as dose equivalent. The dose equivalent in rem is equal to the absorbed dose in rads multiplied by the quality factor Q [(1 rem = 0.01 Sievert) and (1 rem = 1,000 millirem)].

Respiratory protective device—An apparatus, such as a respirator, used to reduce the individual's intake of airborne radioactive materials.

Reference Level—A dose received in any monitoring period that, if continued at the same rate, would exceed the limits specified in AFI 48-148 or 10 CFR Part 20.

Restricted area—An area, access to which is limited by the licensee for the purpose of protecting individuals against undue risks from exposure to radiation sources and radioactive materials.

Restricted area does not include areas used as residential quarters, but separate rooms in a residential building may be set apart as a restricted area.

Shallow-dose Equivalent (Hs)—The external exposure of the skin or an extremity which is taken as the dose equivalent at a tissue depth of 0.007 cm (7 mg cm^2—the average depth of the germinal cell layer) averaged over an area of 1 cm^2.

Sum Committed Dose Deep Dose Equivalent—A dose equivalent category used on RDL Listings 14991 and 14992 showing the total of the committed dose equivalent to a tissue and the whole body deep dose equivalent. This value is limited by 10 CFR 20 to 500 mSv (50 rem) in one year for any organ or issue and is a summation of the internal committed dose equivalent and the external deep dose equivalent. This term is a synonym for Total Effective Dose Equivalent (TEDE).

Sievert (Sv)—The SI unit of any of the quantities expressed as dose equivalent. The dose equivalent in Sievert is equal to the absorbed dose in Gray multiplied by appropriate radiation weighting factors, w_R (1 Sv = 100 rem). One milliSievert (mSv) is 0.001 Sv [(0.1 rem) or (100 mrem)].

Site boundary—That line beyond which the land or property is not owned, leased, or otherwise controlled by the licensee.

Source material—(1) Uranium or thorium, or any combination of uranium or thorium in any physical or chemical form; or (2) ores that contain by weight one-twentieth of 1 percent (0.05 percent), or more, of uranium, thorium, or any combination of uranium and thorium. Source material does not include special nuclear material.

Special nuclear material (SNM)—(1) Plutonium, uranium-233, uranium enriched in the isotope 233 or in the isotope 235 and any other material that the NRC, pursuant to the provisions of section 51 of the Act, determines to be special nuclear material, but does not include source material; or (2) any material artificially enriched by any of the foregoing, but does not include source material.

Stochastic effects—Health effects which occur randomly and for which the probability of the effect occurring, rather than its severity, is assumed to be a linear function of dose without threshold. Hereditary effects and cancer incidence are examples of stochastic effects.

Survey—An evaluation of the radiological conditions and potential hazards incident to the production, use, transfer, release, disposal, or presence of radioactive material or other sources of radiation. When appropriate, such an evaluation includes a physical survey of the location of radioactive material and measurements or calculations of levels of radiation, or concentrations or quantities of radioactive material present.

Termination—The end of employment with USAF and ANG involving personnel radiation monitoring.

Thermoluminescent dosimeter (TLD)—A type of dosimeter that uses powdered or solid phosphor materials (e.g., $Li_2B_4O_7$, LiF, $CaSO_4$) to record radiation exposures. When heated, the phosphor emits light proportional to the amount of radiation energy absorbed. This type of dosimeter consists of a card and a holder (badge).

TLD Holder—A device used to hold the four TLD elements in the whole body, neutron and collar dosimeter.

TLD Hanger—A term used to describe the device used to attach a TLD holder on an individual.

Total effective dose equivalent (TEDE)—The sum of the deep dose equivalent (H_d) (for external exposures) and the committed effective dose equivalent (for internal exposures) expressed in units of either rem or Sv.

Total organ dose equivalent (TODE)—The total organ dose equivalent for the maximally exposed organ. The TODE is the sum of the deep dose equivalent (DDE) and the committed dose equivalent (CDE) expressed in units of rem or Sv.

Unrestricted area—An area, access to which is neither limited nor controlled for purposes of radiation protection.

User—An individual delegated with the authority to use, operate, or store radiation sources and devices.

Very high radiation area—An area, accessible to individuals, in which radiation levels from radiation sources external to the body could result in an individual receiving an absorbed dose in excess of 500 rad (5 Gray) in 1 hour at 1 meter from a radiation source or from any surface that the radiation penetrates. ***Note: For very high doses received at high dose rates, units of absorbed dose (e.g., rad and Gray) are appropriate, rather than units of dose equivalent (e.g., rem and Sievert).***

Visitor—A person who does not normally work in an USAF controlled radiation area, but who may be authorized to enter the area by the IRSO providing suitable dosimetry and/or protective equipment is available.

Week—Seven consecutive days starting on Sunday.

Weighting factor w_T, for an organ or tissue (T)——The proportion of the risk of stochastic effects resulting from irradiation of that organ or tissue to the total risk of stochastic effects when the whole body is irradiated uniformly. For calculating the effective dose equivalent, the values of w_T are shown in Table A1.4.

Table A1.3 Organ Dose Weighting Factors.—

Whole body—For purposes of external exposure, the head, trunk (including male gonads), arms above the elbow, or legs above the knee.

Year—The period of time beginning in January used to determine compliance with the provisions of this part. The licensee may change the starting date of the year used to determine compliance by the licensee, provided that the change is made at the beginning of the year and that no day is omitted or duplicated in consecutive years.

Attachment 2

"DECISION TREES"

A2.1. These "decision trees" are designed to aid in evaluating the need for enrolling an individual in the Dosimetry Program.

A2.2. When asked for guidance on whether an individual needs to be provided with dosimetry services, first determine if dosimetry is mandatory from AFI 48-148, the radioactive material use permit, and other sources. Some occupations where dosimetry is generally mandated are nuclear medicine technicians, radiologists and radiology technicians, non-destructive inspection technicians, pregnant radiation workers, and personnel entering high radiation areas. Many circumstances will be less clearly defined however, and in such cases, the "decision trees" on the following pages may be used to assist in deciding whether or not to enroll an individual in the Dosimetry Program.

A2.3. The following "decision trees" are only advisory in nature. They must **not** be represented as official policy of USAFSAM/OEA or of AFMSA/SG3PB.

A2.4. Except in cases where personnel dosimetry is mandated by AFI 48-148 or other regulation or law, the decision on who receives this service is made at the local base level. USAFSAM/OEA will provide dosimetry if desired at local base level, even if the "decision tree" indicates it is not required.

Figure A2.1. Decision Tree #1 - General Considerations.

Type of Radiation	Quality Factor(Q)	Absorbed dose equal to a unit dose equivalent [a]
X-, gamma, or beta	1	1
Alpha particles, multiple-charged particles, fission fragments and heavy particles of unknown charge	20	0.05
Neutrons of unknown energy	10	0.1
High-energy protons	10	0.1

[a] Absorbed dose in rad equal to 1 rem or the absorbed dose in gray equal to 1 sievert.

Figure A2.2. Decision Tree #2 – Occupational Exposure in Radiation Therapy.

Neutron Energy (MeV)	Quality Factor (Q) [a]	Flux per unit Dose equivalent [b] (neutrons cm^{-2} rem^{-1})	Neutron Energy (MeV)	Quality Factor (Q) [a]	Flux per unit Dose equivalent [b] (neutrons cm^{-2} rem^{-1})
(Thermal) 2.5×10^{-8}	2	980×10^6	5	8	23×10^6
1×10^{-7}	2	980×10^6	7	7	24×10^6
1×10^{-6}	2	810×10^6	10	6.5	24×10^6
1×10^{-5}	2	810×10^6	14	7.5	17×10^6
1×10^{-4}	2	840×10^6	20	8	16×10^6
1×10^{-3}	2	980×10^6	40	7	14×10^6
1×10^{-2}	2.5	1010×10^6	60	5.5	16×10^6
1×10^{-1}	7.5	170×10^6	1×10^2	4	20×10^6
5×10^{-1}	11	39 X&10^6	2×10^2	3.5	19×10^6
1	11	27×10^6	3×10^2	3.5	16×10^6
2.5	9	29×10^6	4×10^2	3.5	14×10^6

[a] Value of quality factor (Q). at the point where the dose equivalent is maximum in a 30-cm diameter cylinder tissue-equivalent phantom.

[b] Monoenergetic neutrons incident normally on a 30-cm diameter cylinder tissue- equivalent phantom.

Figure A2.3. Decision Tree # 3 – Occupational Exposure to X-rays and other Machine Produced Radiation (non-therapy).

Organ or Tissue	w_T
Gonads	0.25
Breast	0.15
Red bone marrow	0.12
Lung	0.12
Thyroid	0.03
Bone Surfaces	0.03
Remainder	0.301
Whole Body	1.002

[1] 0.30 results from 0.06 for each of 5 "remainder" organs (excluding the skin and the lens of the eye) that receive the highest doses.

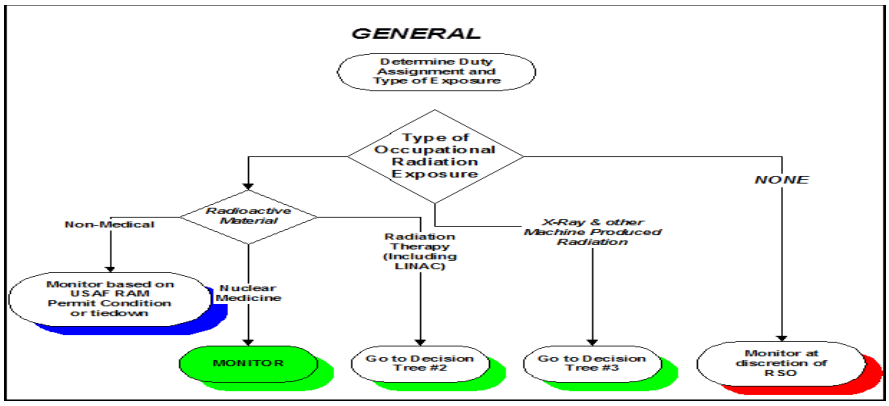
[2] For the purpose of weighting the external whole body dose (for adding it to the internal dose) a single weighting factor, $w_T = 1.0$, has been specified. The use of other weighting factors for external exposure will be approved on a case-by-case basis until such time as specific guidance is issued.

Attachment 3

DESCRIPTION OF AIR FORCE DOSIMETERS

A3.1. Air Force Whole Body Dosimeters.

Table A3.1. Composition of AF Whole Body Dosimeter.



A3.1.1. Evaluating Radiation Dose using Whole Body Dosimeters. The Air Force Dosimetry System utilizes a dose algorithm capable of calculating external whole body doses from photon, beta, and neutron radiation fields. The algorithm calculates absorbed radiation doses from exposures to pure and mixed x-ray, gamma ray, and neutron sources as well as beta particles that may occur in work environments. The range of radiation fields over which the algorithm is applicable is defined by the range of energies of each radiation type used in the algorithm development.

A3.1.1.1. Applicable Radiations. Photon dose calculations accommodate a range of photon energies from 20 to 1.3 MeV. The photon sources used for algorithm development were chosen for applicability to the NVLAP proficiency-testing category IIA (photons general). The beta () shallow and eye dose calculations apply to average beta energies between 0.556 MeV ($^{90}Sr/^{90}Y$) and 0.267 MeV (^{204}Tl).

A3.1.1.2. Evaluating Neutron Exposures with the Whole Body TLD. The neutron dose calculation is specific for deuterium oxide (D_2O) (heavy water) moderated ^{252}Cf. This source/geometry is used to generally simulate a nuclear power plant neutron energy spectrum. The neutron spectrum greatly affects dosimeter response and, consequently, can have a significant impact on the dose equivalent assessed for individuals wearing the badge. Monitoring programs for neutron exposures should be coordinated with USAFSAM/OEA and USAFSAM/OEA to determine whether neutron spectroscopy measurements are required to provide an accurate determination of neutron dose. The dose processing software has been customized to allow the use of customer-specific; source determined neutron factors to accommodate neutron sources other than D_2O moderated ^{252}Cf. When available, use of customer-specific neutron factors is preferred. **Note: When neutron exposure is expected a neutron specific TLD should be worn.**

A3.1.1.3. Algorithm Limitations for Neutron Fields. All neutron fields will have a gamma component and a beta component. Differentiating neutron external exposure, gamma exposure, and beta exposure is important because of the difference in quality

factors (Q) for each and the need to determine the beta component of the shallow dose. The need to differentiate these doses is the reason the UD-802 has two phosphors ($CaSO_4$:Tm and $Li_2B_4O_7$:Cu) and the Air Force uses two holders—one for beta/gamma fields, smoky (clear); and one designed for neutron detection. The $CaSO_4$:Tm is relatively insensitive to neutron radiation but is sensitive to beta and gamma. The $Li_2B_4O_7$:Cu phosphor is sensitive to all three types of radiation. The general approach used is to design the holders to emphasize a phosphor's response to one of the three types of radiation of concern and then use algorithms to convert the phosphor's response to gamma dose, neutron dose, and shallow (basically skin) dose.

A3.1.1.3.1. The process in beta/gamma fields is relatively simple. The holder (smoky/clear) is designed to shield $CaSO_4$:Tm phosphor from all beta radiation and to allow the $Li_2B_4O_7$:Cu to respond to both beta and gamma radiation. $CaSO_4$:Tm phosphor response will be directly related to the gamma dose (deep dose). An algorithm is used that uses the $CaSO_4$:Tm phosphor response to essentially remove the gamma response from the $Li_2B_4O_7$:Cu phosphor. The remaining is attributable to the beta (shallow) dose.

A3.1.1.3.2. The process in neutron fields is more complex because there are three types of radiation (beta, gamma and neutron) and only two phosphors. The holders are used to make up the difference. The yellow holder for the neutron dosimeter is designed to maximize the response of the $Li_2B_4O_7$:Cu phosphor to neutrons and it does this by adding sufficient plastic shielding to eliminate all beta radiation. As with the smoky/clear badge, the $CaSO_4$:Tm phosphor is used to measure the gamma dose and is shielded from all beta radiation. This means the neutron dosimeter (yellow holder) cannot measure beta radiation.

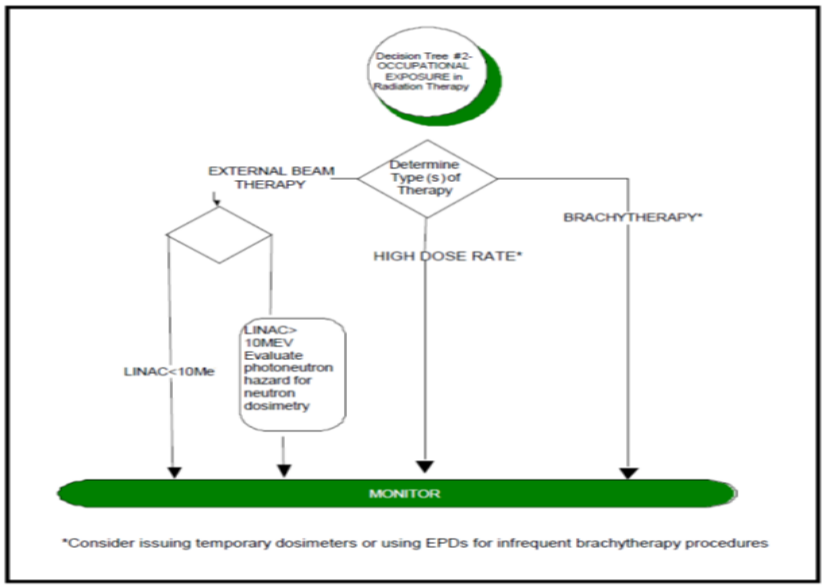
A3.1.1.3.3. This shortcoming is overcome also by wearing the beta/gamma dosimeter (smoky/ clear) where the holder is designed to allow beta irradiation to reach the $Li_2B_4O_7$:Cu phosphor. The additional challenge is that the $Li_2B_4O_7$:Cu phosphor in the beta/gamma dosimeter responds to both beta and neutron radiation. In a procedure similar to the one above, an algorithm uses the responses of the gamma-optimized phosphor ($CaSO_4$:Tm in both holders) and the neutron optimized phosphor ($Li_2B_4O_7$:Cu in the yellow holder) to separate the neutron and gamma responses from the $Li_2B_4O_7$:Cu phosphor in the smoky/clear holder. As above, the remaining response is due to beta (shallow) dose.

A3.1.1.4. Lower Limit of Detection. At low dose levels, normal statistical variation in the element readings makes calculation of energy specific correction factors inherently unreliable. An LLD study was performed using the protocol specified by the Department of Energy Laboratory Accreditation Program (DOELAP) standard in publication DOE-EH-0027. The LLDs for most radiations evaluated in the algorithm were calculated to be between 0.001 – 0.0025 mSv (0.1 - 2.5 mrem). Because of increased uncertainties inherent with field deployment of personnel dosimeters, an administratively determined minimum dose level of 0.1 mSv (10 mrem) is applied when reporting doses to the MRER. This is consistent with generally accepted LLD reporting practices throughout the external radiation dosimetry industry.

A3.1.1.5. High Responses. High range doses require special attention. Any element reading above 417 mR* (element readout) is reported on the raw data printout obtained after the readout is complete . If the estimated deep dose on a dosimeter issued to a person (as opposed to a dosimeter used for calibration, blind testing, or similar purposes) is greater than 417 mrem and the element glow curves are satisfactory, the base IRSO and the Air Force Radioisotope Committee (RIC) are contacted . The TLD is isolated and a follow-up investigation is initiated as detailed in the Dosimetry Laboratory Operating Instructions (OIs) and the Air Force Manual (AFMAN). The high reading is noted on the dose processing form.

A3.1.2. Evaluating Radiation Doses using Neutron Dosimeters. The Air Force neutron dosimeter uses the same TLD as is included with the whole body dosimeter. A specialized neutron hanger with a 314 mg/cm^2 cadmium filter over the front of Element 1 is provided. The cadmium filter improves the dosimeter's response to the wide range of neutron energies that may be operationally encountered. As noted above, the amber neutron dosimeter is never worn alone, but in combination with the standard "smoke" colored dosimeter/hanger combination.

Table A3.2. Composition of AF Neutron Dosimeter.



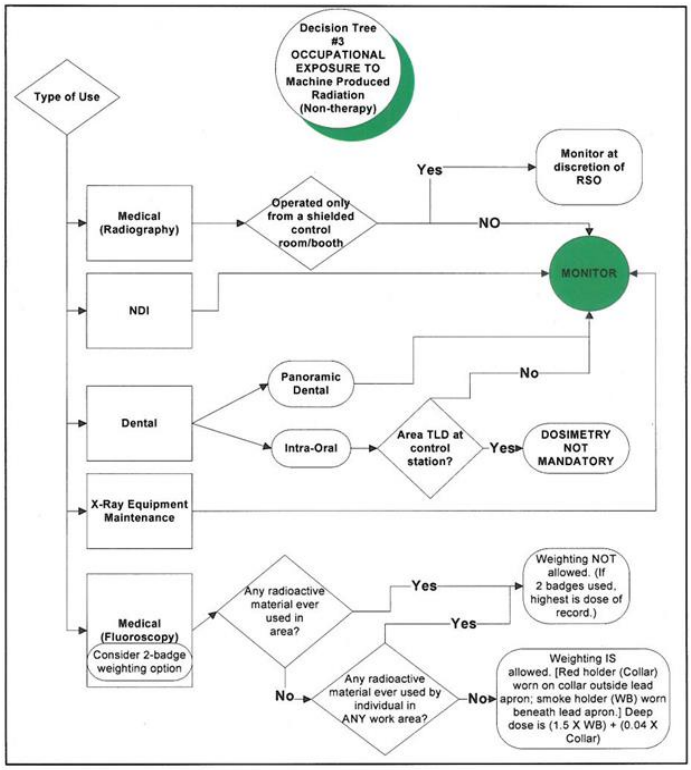
A3.1.2.1. Applicable Radiations. Photon response of the amber hanger UD-802 dosimeter is characterized at gamma photon energy of 662 keV (^{137}Cs). The photon sources used for algorithm development were chosen for applicability to the NVLAP proficiency testing categories II and VI. The neutron dose calculation is specific for D_2O moderated ^{252}Cf. This type of source is used to generally simulate a nuclear power plant neutron energy spectrum. The neutron spectrum greatly affects the dose equivalent of the neutron exposure. If field neutron energies can be identified and measured, site-specific correction factors can be applied to increase the accuracy of the dose estimate.

A3.2. Air Force Extremity Dosimeters.

A3.2.1. As stated in paragraph 3.2.2, the dose calculation algorithms for the single element extremity dosimeter (EXT-RAD) do not automatically compensate for exposures to beta radiation at energies other than those used to characterize the dosimeter (i.e., 0.556 MeV $^{90}Sr/^{90}Y$ and 0.267 MeV ^{204}Tl). Because of this inherent limitation in dosimeter design, it is important that the customer advise the laboratory of the type and energy of beta radiation for which the dosimeter is to be evaluated so that appropriate correction factors can be applied to compensate for extremity dosimeter under response with low energy beta () radiations. Experimental data illustrates that when exposed to radiation from ^{204}Tl, the EXT-RAD dosimeter exhibits significant under response when compared to that obtained from the same delivered dose of $^{90}Sr/^{90}Y$. The EXT-RAD will not be sensitive to very low energy emitters like ^{14}C or tritium (^{3}H), most alpha emitters (although it may respond to the characteristic x-rays they emit), or to low energy x-ray (low voltage tubes).

A3.2.2. The approximations listed in Table A3.3 may be applied to compensate for anticipated EXT-RAD under response when the identity of the beta emitter is known. It is essential that the customer inform USAFSAM/OEA of the energy of beta radiation desired for evaluating dosimeter results so that appropriate energy correction factors can be applied. Unless otherwise specified by the customer, the calculation software presumes that the beta radiation is of an energy closely approximating that of $^{90}Sr/^{90}Y$ (0.556 MeV).

Table A3.3. Response vs. Energy—Bicron/Harshaw Extremity Dosimeters.



A3.2.3. Bicron/Harshaw EXT-RAD Extremity Chipstrate Dosimeter: The Bicron/ Harshaw EXT-RAD extremity dosimeter is a single-element "ring"-type dosimeter. The active phosphor EXT-RAD dosimeter is a LiF:Mg,Tl chip with a permanent, individual barcode. The manufacturer refers to the chip/barcode assembly as a "chipstrate." The chipstrate is

heat sealed into a plastic throwaway pouch with adjustable attachment straps to form the complete dosimeter. The chipstrate has inherent attenuation of approximately 100 mg/cm**2**. The pouch adds an additional 7 mg/cm**2** attenuation, for a total attenuation of approximately 107 mg/cm**2**. Absorbed doses are calculated based on the background-corrected element response exhibited when the dosimeter is read in a properly calibrated Bicron/Harshaw 6600 Automatic TLD reader.

A3.2.3.1. Ring response is calibrated using a number of radiation sources including **137**Cs, **90**Sr/**90**Y, and **204**Tl. A review of experimental data from test irradiations made by the Pacific Northwest National Laboratory (PNNL) showed that, when exposed to low-energy radiation from **204**Tl, the Air Force EXT-RAD dosimeter under-responds by about 50%. This means that the energy compensation coefficient (ECC)-corrected raw data results for an EXT-RAD dosimeter exposed to **204**Tl are about half the actual absorbed dose equivalent. The calculated ECC (E_n) for **204**Tl with the USAF EXT-RAD dosimeter is 0.50.

Figure A3.1. EXT-RAD "band-aid" Chipstrate Extremity Dosimeter.

UD-802	Element 1	Element 2	Element 3	Element 4
Phosphor	$Li_2B_4O_7$: Cu		$CaSO_4$: Tm	
Shielding	Plastic	Plastic		Plastic + Lead
Thickness (mg/cm^2)	18	360		1040

Figure A3.2. EXT-RAD Extremity Dosimeter in Use.

UD-802	Element 1	Element 2	Element 3	Element 4
Phosphor	$Li_2B_4O_7$: Cu		$CaSO_4$: Tm	
Shielding	Front, Plastic + Cadmium Back, Plastic	Plastic		Plastic + Lead
Thickness (mg/cm^2)	Front, 314 Back, 220	360		1040

Attachment 4

AIR FORCE DOSIMETRY PROGRAMOSIMETRY PROGRAM

Table A4.1. Adding An Individual to the AF Dosimetry Program

Isotope	Energy (β max ave)	EXT-RAD Response
^{204}Tl	0.267	0.4967
	0.3	0.5459
	0.32	0.5756
	0.35	0.6203
	0.36	0.6352
	0.38	0.665
	0.4	0.6948
	0.42	0.7245
	0.44	0.7543
	0.46	0.7841
	0.48	0.8139
	0.5	0.8437
	0.52	0.8734
	0.53	0.8883
$^{90}Sr^{90}Y$	0.556	0.927
^{137}Cs	0.662	0.949
EXT-RAD Response = 1.4889 $X_{(MeV)}$ + 0.0992		

Table A4.2. Deleting and Individual from the AF Dosimetry Program.

Table A4.3. Changing Registry Information Concerning an Individual Enrolled in the AF Dosimetry Program.

Table A4.4. Assembling Whole Body, Collar and Neutron Dosimeters.

Checklist—Adding an Individual to the AF Dosimetry Program				
Enter Yes, No, N/A or √when completed (as appropriate)	Yes	No	N/A	√
Ask the individual whether he/she has had previous exposure to ionizing radiation prior to registering into the program.				
If yes and the previous exposure was during assignment to another Air Force installation, request an AF Form 1527-2 from USAFSAM/OEHHD.				
If yes, and the previous exposure was during civilian employment, request an NRC Form 4, Occupational Radiation Exposure History (or equivalent), from the individual's employer prior to allowing the person to work in a radiation area. *Note: If a release statement is signed, this information may be obtained directly from the previous employer but must be forwarded to USAFSAM/OEHHD upon receipt for addition to the MRER.*				
Inform the individual that if a job outside the Air Force is desired, he/she must provide an NRC Form 5, Current Occupational Radiation Exposure (or equivalent), for each monitoring period they are employed.				
To add the individual to the base radiation Dosimetry Program, use the USAFSAM Portal and the Radiation Dosimetry Web Personnel Information Change module. The following information will be required:				
Area				
Name (last, first, middle initial)				
SSN				
Date of Birth (month, day, year)				
Gender (M/F)				
TLD type (e.g., UD-802AT)				
TLD ID number				
Wear location (e.g., finger, collar, body, nbod [for neutron dosimeter])				
Occupational Code (see Attachment 5)				
Date of issue				
Note: When the individual requires multiple badges, it is only necessary to provide the information above once for subsequent badges.				
If registering a **foreign national** into the program:				
For the **initial** registration, enter "FORNAT" in the SSN column of the listing.				
For previously registered Foreign Nationals, enter the "mock" SSN assigned by USAFSAM/OEHHD for ID purposes in the SSN column.				
Complete the Personnel Information Change form using the USAFSAM Portal and the Radiation Dosimetry Web				
If the individual is a one-time user (e.g., a visitor, student, special study) show this as "one time" in the remarks.				
Issue an extra dosimeter to the individual.				
At the end of the monitoring period, submit all dosimeters for individual(s) added to the program to USAFSAM/OEHHD.				

Table A4.5. Reviewing OEHHD Dose Equivalent Report.

Checklist—Deleting an Individual From the AF Dosimetry Program				
Enter Yes, No, N/A or √ when completed (as appropriate)	Yes	No	N/A	√
Did the individual wear the dosimeter during the monitoring period?				
If yes, complete the Personnel Information Change form using the USAFSAM Portal and the Radiation Dosimetry Web and indicate that the individual should be deleted from the program.				
If no, complete the Personnel Information Change form using the USAFSAM Portal and the Radiation Dosimetry Web and indicate that the individual should be deleted from the program, and on the 1523 module indicate that the TLD assigned to the individual was NOT WORN.				
At the end of the monitoring period, submit all dosimeters for individual(s) deleted from the program to USAFSAM/OEHHD.				

Table A4.6. Reviewing Individual Dose Report.

Checklist—Changing Registry Information Concerning an Individual Enrolled in the AF Dosimetry Program				
Enter Yes, No, N/A or √ when completed (as appropriate)	Yes	No	N/A	√
Complete the Personnel Information Change form using the Radiation Dosimetry Web secure website:				
Base code				
Name (as printed on RDL Listing 1523)				
SSN (as printed on RDL Listing 1523)				
Area code (as printed on RDL Listing 1523)				
Old or incorrect information				
New or correct information				
To **increase or decrease** the number of dosimeters for an individual, change the type of dosimeters to be assigned to the individual.				

Table A4.7. Dosimeters Lost or Not Returned to the IRSO by the Area Monitor.

Checklist—Assembling Whole Body, Collar and Neutron Dosimeters				
Enter Yes, No, N/A or √ when completed (as appropriate)	Yes	No	N/A	√
Remove the TLDs from the shipping tray (if provided).				
Determine the hanger type from the RDL Listing 1523 and its corresponding ID label. **SMOKE COLORED HANGERS** - Whole body dosimeters or collar dosimeters (when worn alone), including badges worn beneath a shielded lead apron. **AMBER COLORED HANGERS** - Neutron dosimeters. **RED COLORED HANGERS** - Collar badges (worn at collar level outside the shielded lead apron) when worn in conjunction with a whole body dosimeter. (The preprinted label will specify the location to be worn and corresponding TLD number for each individual.)				
Use a small screwdriver or the appropriate tool for the Red hangers to open the hanger.				
Visually inspect the hanger for damage. Damaged hangers must **not** be issued.				
Confirm that the Mylar™ window is intact.				
Confirm that the black gasket is intact.				
Confirm that the hanger hinge mechanism is operating properly.				
Place the opened hanger on a table with the part of the hanger with the word "front" closest to you. (This side has a small peg towards the hinge of the badge.)				
Place the TLD holder in the hanger in such a way that the TLD type number (e.g., UD-802AT) is facing to the left. (The TLD holder will only go in one way.)				
Locate the correct preprinted label.				
Confirm that the TLD number and ID label match the RDL Listing 1523 entry.				
Place the label onto the TLD holder with the printed side facing up so that the label can be easily read.				
Close the hanger. You should hear a click. Do not force the hanger to close.				
If the hanger is difficult to close:				
Reposition the TLD and try again.				
Confirm that the black gasket is properly installed in the hanger.				
Continue this procedure until all TLDs and labels are assembled in the proper holders.				

Table A4.8. Issuing Dosimeters.

Checklist—Reviewing OEHHD Dose Equivalent Report (RDL Listing 1499-1 and/or RDL Listing 1499-2)				
Enter Yes, No, N/A or √ when completed (as appropriate)	Yes	No	N/A	√
Have you received the RDL Listings 1499-1 and 1499-2 covering specific monitoring periods?				
IRSO reviews listings for administratively assigned dose equivalents and abnormal dose equivalent results.				
IRSO reviews listings for compliance with 10 CFR 20 and AFI 48-148.				
Are the Total effective dose equivalent (TEDE) <0.417 rem (4.17 mSv) monthly or <1.250 rem (12.5 mSv) quarterly? If not, initiate Abnormal Exposure Investigation.				
Deep dose equivalent to pregnant radiation worker <0.05 rem (0.5 mSv monthly) or < 5 mSv (0.5 rem) for duration of pregnancy. If not, initiate Abnormal Exposure Investigation.				
Eye dose equivalent <1.250 rem (12.5 mSv) monthly or <3.750 rem (37.5 mSv) quarterly. If not, initiate Abnormal Exposure Investigation.				
Shallow dose equivalent to skin or extremity <4.17 rem (41.7 mSv) monthly or <12.5 rem (125 mSv) quarterly. If not, initiate Abnormal Exposure Investigation.				
Sum of deep dose equivalent and committed dose equivalent to any individual organ or tissue other than the lens of the eye equivalent <12.50 rem (125 mSv) quarte or <4.16 rem (41.6 mSv) monthly. If not, initiate Abnormal Exposure Investigation.				
Confirm that totals for the year, as reflected on the RDL Listing 1499-2, equal the sum of each monitoring period starting with 1 Jan of that year.				
IRSO signs the forms as being reviewed and indicated the investigation action level *(see glossary)* for the specific area on the form.				
IRSO provides the area monitor or supervisor with a copy of these listings.				
Area monitor or supervisor reviews listings with the individuals upon receipt to ensure all information is accurate and complete.				

Table A4.9. Lost, Damaged, or Not Received Dosimeters.

Checklist—Reviewing Individual Dose Report (AF Form 1527-1 and/or AF Form 1527-2)				
Enter Yes, No, N/A or √ when completed (as appropriate)	Yes	No	N/A	√
Confirm receipt of an annual AF Form 1527-1 for each individual currently in the program.				
If adding an individual to the program, request an AF Form 1527-2 from USAFSAM/OEHHD or through Radiation Dosimetry Web secure website.				
Request an AF Form 1527-2 from USAFSAM/OEHHD for each individual in the program who is retiring or separating from the Air Force during the year or through the USAFSAM Portal and the Radiation Dosimetry Web secure website.				
Upon receipt, check individual's monthly/quarterly entries for the current year against the RDL Listings 1499-1 and 1499-2 received during the year.				
Monitored individual signs the form indicating concurrence with information.				
IRSO signs the form indicating concurrence with the information presented.				
For any discrepancies, corrections, additions or deletions that can be substantiated,				
Note all changes on the form prior to posting in the individual's medical record.				
Notify USAFSAM/OEHHD of the needed changes so the MRER can be updated.				
Obtain an updated form from USAFSAM/OEHHD or through the USAFSAM Portal and the Radiation Dosimetry Web secure website.				
Place the AF Form 1527-1 or 1527-2 into the individual's medical record.				
Remove and destroy any old AF Forms 1527-1 or 1527-2 that are in the individual's medical record.				

Table A4.10. Monitoring of Pregnant Radiation Workers.

Checklist—Dosimeters Lost or Not Returned to the IRSO by the Area Monitor				
Enter Yes, No, N/A or √ when completed (as appropriate)	Yes	No	N/A	√
Contact the area monitor to assist in accounting for the dosimeter(s).				
Circle the dosimeter number on the RDL Listing 1523 to show some type of problem with the dosimeter.				
Indicate in the remarks column on the listing the reason for not collecting the dosimeter (e.g., TDY, leave, PCS, lost).				
Initiate a review of the dose equivalent records to be ready to assign a dose equivalent once the notification is received from USAFSAM/OEHHD.				
If a dosimeter that was not collected from a previous period is recovered, transfer all monitoring information on the old RDL Listing 1523 to the current period, and enter the actual collection date.				
Action to take if a dosimeter previously reported as lost is recovered:				
Complete all information on the RDL Listing 1523 as though adding a person to the program.				
Show the dosimeter as "recovered" in the remarks column.				
If a dosimeter is not worn, circle the dosimeter number, return it at the end of the monitoring period and write "not used" in the remarks column of RDL Listing1523.				

Table A4.11. Receipt and Inspection of Dosimeters.

Checklist—Issuing Dosimeters				
Enter Yes, No, N/A or √ when completed (as appropriate)	Yes	No	N/A	√
Divide all the dosimeters into groups according to area.				
Check each assembled whole body, neutron, collar, or extremity dosimeter label against the RDL Listing 1523.				
Confirm that there is an entry for each individual.				
Confirm that the TLD holder or finger label number matches with the person's name.				
Confirm that the label and RDL Listing 1523 show the same wear location.				
Provide dosimeters to the area monitor within two (2) calendar days of the end of the previous monitoring period.				
Area monitor issues dosimeters to the individual listed on the dosimeter label.				
Instruct area monitor that:				
A. Under no circumstance is a dosimeter to be opened at the using activity.				
B. Dosimeters must not be collected from individuals without an exchange dosimeter being available.				
C. Any dosimeter with a suspected high exposure must be returned as soon as possible for analysis.				
D. Any damaged dosimeter must be returned to the TLD monitor for exchange.				
Confirm that individuals store dosimeters in the proper non-use storage location.				
Confirm that control dosimeters are maintained in the designated dosimeter storage location(s).				
Confirm that individuals are wearing the dosimeters in the proper locations as indicated.				
Are any dosimeters exchanged before the end of the monitoring period for which they are intended?				

Table A4.12. Requesting a Report of Radiation Exposure History (AF Form 1527-2).

Checklist—Lost, Damaged, or Not Received Dosimeters				
Use this checklist when notified by USAFSAM/OEHHD of dosimeters **Not Received**				
Enter Yes, No, N/A or √ when completed (as appropriate)	Yes	No	N/A	√
IRSO reviews the previous twelve months of monitoring data for the individual and co-workers in the area involved.				
Area monitor or supervisor prepares a statement describing the worker's activities over the monitoring period involved, including workload, changes in procedures, etc.				
Monitored worker signs the statement indicating concurrence with the dose estimate or submits an alternative signed statement of non-concurrence.				
After reviewing the summary of duties and previous exposure history, IRSO determines a dose equivalent to be assigned for the period involved.				
Fill out the Administrative Dose Change form using the USAFSAM Portal and the				
The dose equivalent to be assigned.				
Dosimeter number, type and monitoring period.				
Name and SSN of the individual.				
Statement signed by the individual (if available for signature) to show concurrence with the assigned dose.				
File a copy of the assigned dose equivalent determination in the workplace case file.				
File a copy of the assigned dose equivalent determination in the individual's health record.				
Complete all actions within 30 calendar days from the receipt of the notification.				

Table A4.13. Returning TLDs to USAFSAM/OEHHD for Processing.

Checklist—Monitoring of Pregnant Radiation Workers				
IRSO notifies USAFSAM/OEHHD by completing a Personnel Information Change form using the USAFSAM Portal and the Radiation Dosimetry Web secure website.				
Enter Yes, No, N/A or √ when completed (as appropriate)	Yes	No	N/A	√
For each notification, provide the following information:				
Individual's name.				
SSN.				
Base name and base code.				
Estimated date of conception.				
Confirm that all pregnant radiation workers are monitored on a monthly monitoring cycle.				
If the individual works in an area normally monitored quarterly:				
Change the area to "PF" monthly to ensure proper dosimeter exchange and control.				
Advise the pregnant radiation worker that even though her dosimeter may maintained on a different control board due to the change to monthly monitoring, she can still work in her normal work setting by retrieving and returning her dosimeter, when not being worn, to that control board.				
Change the area back to the worker's normal area when the pregnancy is terminated.				

Checklist—Receipt and Inspection of Dosimeters				
Complete the following promptly upon receipt of a shipment of dosimeters from af radiation dosimetry laboratory				
Enter Yes, No, N/A or √ when completed (as appropriate)	Yes	No	N/A	√
Carefully open the shipping container and visually inspect for damage to its contents.				
Confirm receipt of all the necessary materials:				
Shipping tray(s) with TLDs.				
Preprinted identification labels.				
RDL Listing 1523.				
Extremity dosimeters, if needed.				
Verify that there are enough dosimeters, including extras, for the base monitoring requirements.				
NOTE: The shipping trays are arranged by:				
First area control TLDs for each dosimeter				
First area beta/gamma/x-ray TLDs				
First area neutron TLDs				
(Sequence is repeated for each area until all areas are complete)				
Extra base beta/gamma/x-ray TLDs				
Extra base neutron TLDs				
Extremity dosimeters (packaged separately)				
Verify that there are control TLDs and control extremity dosimeters for each monitored area.				
Store the original shipping container so that it can be used at the end of the monitoring period to return the TLDs to USAFSAM/OEHHD.				

Table A4.14. Evaluating Doses Exceeding Reference Levels.

Checklist—Requesting a Report of Radiation Exposure History (AF Form 1527-2)				
Note: The IRSO also may obtain the Radiation Exposure History (AF Form 1527-2) of any individual currently stationed at his/her base through the Radiation Dosimetry Web secure website.				
Installation Radiation Safety Officer (IRSO) prepares a letter of request containing:				
Enter Yes, No, N/A or √ when completed (as appropriate)	Yes	No	N/A	√
Name of individual (last, first, MI).				
Social Security Number (SSN) of individual.				
Date of Birth of individual.				
Signature of individual authorizing release of personal information.				
Signature of IRSO requesting the report.				
Address to which the report is to be sent.				
Telephone number (commercial and DSN) of IRSO (or individual) requesting the report.				
FAX number of IRSO (or individual) requesting the report.				
E-mail address of IRSO or individual requesting the report (report will not be sent by email).				
Send requests by mail or FAX to:				
USAF Radiation Dosimetry				
USAFSAM/OEHHD				
To protect the privacy of individuals receiving monitoring service, requests received by email or				
USAFSAM/OEHHD will research available AF records of internal and external ionizing radiation				
Any individual who has received AF radiation monitoring service may request a copy of their				

Attachment 5

OCCUPATIONNAL CODES

Table A5.1. Occupational Codes.

	Medical X-Ray		**Radar**
6	Medical Maintenance	60	Radar Operators
7	Physician: Interventional Radiologist	61	Radar Maintenance Personnel
8	Physician: Cardiologist	62	Radar Administration/Supply Personnel
9	Physician: Gastroenterologist	63	RF R&D Operations
10	X-Ray Technician	64	Not used
11	Physician: Radiologist (X-Ray)	65	Not used
12	Physician: Urologist	66	All Airborne Radar Personnel
13	Physician: Orthopedist	67	BMEWS Personnel
14	Physician: Anesthesiologist	68	Space-Track Facilities Personnel
15	Physician: Other (X-Ray&Fluoro)	69	Not used
16	Nurse and Nurse Anesthetist		
17	Technician: Other (X-Ray)		
18	Student (Medical X-Ray)		
19	Temporary: Medical X-Ray		
	Dental and Veterinary X-Ray		**Special Weapons**
20	Dental Technician	70	Weapons Maintenance
21	Dentist: General	71	Weapons Inspection
22	Dentist: Oral Surgeon	72	Weapons Personnel
23	Student: Dental and Veterinary	73	High Altitude Sampling
24	Not used	74	Kr-85 (Batteries)
25	Not used	75	Fission Product Contamination
26	Veterinarian	76	Electron Microscope
27	Veterinary Technician	77	Not used
28	Veterinary Research Technician	78	Not used
29	Military Working Dog Handlers	79	Not used
	Medical Use of Radioisotopes (Other than X-Ray)		**Reactors**
30	Physician: Pathologist	80	Reactor Operators
31	Physician: Radiologist (Isotopes)	81	Nuclear Engineers
32	Physician: Other	82	SNAP Projects
33	Technician: X-Ray and Isotopes	83	Nuclear Powered Missiles
34	Technician: Laboratory	84	In Training
35	Technician: Other (Isotopes)	85	Waste Processing
36	Nurse (all categories not already listed)	86	Not used
37	Technician: Radioisotope Laboratory		
38	Pharmacist: Nuclear Medicine		
39	Ophthalmology Oncologist		
	Industrial Use of Radioisotopes (Other than X-Ray)		**Miscellaneous**
40	60Co Instrument Calibration (PME Lab)	87	Scientists
41	Radium Dial Painting	88	Engineers

42	Industrial Radiography (Isotopes)
43	137Cs Instrument Calibration (PME Lab)
44	Not used
45	Electron Tubes
46	Mag-Thorium Operations
47	Isotopes Other than Above (Specify)
48	Training Sources
49	Not used
	Industrial X-Ray (NDI)
50	Portable Field Units
51	Not used
52	Super Voltage Units
53	Not used
54	Not used
55	Postal Inspection Units
56	OSI Inspection Units
57	Baggage Inspection
58	X-Ray Diffraction
59	Not used
89	Physicists
90	AF Contractors
91	Radioactive Waste Disposal Personnel
92	Maintenance Personnel
93	Administrative and Supply Personnel
94	Disaster Control
95	EOD Personnel
	Health Physics and Environmental
96	Health Technician
101	Speech Pathologist
102	Medical Physicist
	Technicians
	Health Physicist and Bioenvironmental
97	Engineer
98	Visitors
99	None of the Above (* See Note Below)
100	Non AF Employment
111	Nevada Test Site
901	Test Occ Code (Reserved)
902	Test Occ Code (Reserved)
903	Test Occ Code (Reserved)

Attachment 6

ELECTRONIC PERSONAL DOSIMETER DOSE PROCESSING WORKSHEET (EPDDPW)

Figure A6.1. Electronic Personal Dosimeter Dose Processing Worksheet (EPDDPW).

Checklist—Returning TLDs to USAFSAM/OEHHD for Processing				
Enter Yes, No, N/A or √ when completed (as appropriate)	Yes	No	N/A	√
WITHIN TWO (2) CALENDAR DAYS OF THE END OF THE MONITORING PERIOD				
Assemble the whole body, neutron, and collar dosimeters and collect the extremity dosimeter rings for the next monitoring period.				
Contact each area monitor to make arrangements for exchange.				
Collect all dosimeters from all areas.				
Each area monitor has returned the dosimeters?				
Each area monitor has returned all area controls?				
Each area monitor has accounted for all dosimeters that were not returned?				
Check all returned dosimeters against RDL Listing 1523 by checking off each entry on the listing as you find it.				
Request each area monitor to assist in accounting for missing dosimeters.				
Designate all "not returned" TLD badges and extremity dosimeters on RDL Listing 1523.				
Remove the TLDs from the hangers using the reverse procedure for dosimeter assembly.				
Discard all labels in a manner designed to ensure that privacy act information is handled properly. You do not need to include labels in shipping trays or shipping packages. (Exception: late return badges not being returned with the original shipment.)				
Screen TLDs with radiation monitoring instrumentation to ensure no exterior contamination is present before shipping.				
Place all TLDs into the shipping tray(s), or shipping container (Example: Zip-Loc™ bag). Badges should sit upright in tray and not at an angle. Badges shipped in trays need to be secured with rubber bands. **Do not use tape to secure badges in tray(s).** (When shipping items from two or more monitoring periods in the same package, keep the items from each monitoring period separate. Special surveys for the monitoring period also need to be separated from monthly and quarterly badges. Individual TLDs do not need to be in order.)				